DOCUMENT RESUME

ED 324 841 EC 232 185

AUTHOR Colker, Laura J.; And Others
TITLE Investigation of Interactive Technologies for Early Math and Science Concepts for Preschool Children. Report--Phase I.
INSTITUTION Macro Systems, Inc., Silver Spring, Md.
SPONS AGENCY Special Education Programs (ED/OSERS), Washington, DC.
PUB DATE 13 Apr 90
CONTRACT RS89071011
NOTE 180p.
PUB TYPE Reports - Evaluative/Feasibility (142) -- Tests/Evaluation Instruments (160) -- Information Analyses (070)

EDRS PRICE MF01/PC08 Plus Postage.
DESCRIPTORS *Classification; Computer Assisted Instruction; Computer Software Development; *Disabilities; *Instructional Design; Instructional Materials; *Interactive Video; Material Development; *Mathematics Instruction; Microcomputers; *Number Concepts; Preschool Education; Science Instruction; Teaching Methods; Videodisks

ABSTRACT

This report describes phase 1 of a projected 2-phase project designed to investigate the feasibility of developing an interactive videodisc to teach math and science concepts to preschool handicapped children. A videodisc system is proposed that would allow children to manipulate real-world objects in order to acquire concrete knowledge about abstract concepts. The report covers Phase 1 activities, including target audience specification, literature review, interviews with experts in the relevant fields, product review, hardware and software review, the enlisting of industry support, and the design team meeting. A design plan is presented which specifies the target audience, educational principles, content, products, design components, and program operation. Appendices making up the greater part of the document include letters of support, copies of survey instruments, a summary of the design team meeting, the review of the literature, summaries of interviews with experts, and a product review. The literature review of 66 references covers the use of microcomputers in teaching preschool math and science, the use of microcomputers in early childhood special education, the use of videodiscs with children, teaching science and math concepts in the preschool, and adapting preschool math and science for special education. The product review describes 121 math and science software programs available for preschoolers. Includes 13 references. (JDD)

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FINAL REPORT – PHASE I

INVESTIGATION OF INTERACTIVE TECHNOLOGIES FOR EARLY MATH AND SCIENCE CONCEPTS FOR PRESCHOOL CHILDREN

FOR
SBIR CONTRACT #RS89071011

MACRO
macro systems inc.

EC 233185

FINAL REPORT – PHASE I

INVESTIGATION OF INTERACTIVE TECHNOLOGIES FOR EARLY MATH AND SCIENCE CONCEPTS FOR PRESCHOOL CHILDREN

Laura J. Colker
Elaine Robey
Carolyn DeMeyer Harris

Macro Systems, Inc.
Silver Spring, Maryland 20910

This material is based upon work supported by the U.S. Department of Education under Contract Number RS89071011. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views or policies of the Department of Education.

Submitted to:

U.S. Department of Education
Office of Special Education Programs
Washington, D.C. 20202

Attention: Jane Hauser
Project Officer

SBIR Contract Number: RS89071011

FINAL REPORT – PHASE I

INVESTIGATION OF INTERACTIVE TECHNOLOGIES FOR EARLY MATH AND SCIENCE CONCEPTS FOR PRESCHOOL CHILDREN

Prepared by:

Macro Systems, Inc.
8630 Fenton Street, Suite 300
Silver Spring, Maryland 20910

Contact Person:

Louise S. Appell, Ph. D.
Principal Investigator

April 13, 1990

ACKNOWLEDGMENTS

We want to express our appreciation to the Design Team members, who furnished a wealth of background information and names of knowledgeable contact people during the initial work, read and commented on the literature and product reviews, helped make the tough decisions during the Design Team meeting, and provided feedback on the preliminary design document. We also want to thank the experts who agreed to the telephone interviews that provided us with first-hand knowledge of the state of the art. Our thanks to:

Design Team Members

Ms. Ellen Bialo, Interactive Educational Systems Designs, Inc.
Mr. David Hopwood, Video Software Associates, Inc.
Dr. Linda Tsantis, IBM Corporation

Interviewees

Mr. W. Buckleitner, High/Scope Foundation
Ms. J. Davidson, University of Delaware
Dr. S. Haugland, Southeast Missouri State University
Dr. K. Hebbeler, Office of Special Education Programs
Dr. P. Morrissey, House Committee on Education and Labor
Dr. D. Shade, University of Delaware
Dr. J. A. Watson, University of North Carolina – Greensboro
Dr. D. Wolfinger, Auburn University

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Chapter I. Overview

I. Background

Since the passage of the 1986 Education of the Handicapped Amendments with its requirement that states include services for 3 to 5 year old handicapped children, national attention has focused on how this goal might best be met. Clearly, technology holds great promise (Swick, 1989).

Over 350 software programs are currently available for preschool children (Buckleitner, 1989). Initial research in the use of computer software with preschoolers has shown that computers can be used to provide developmentally appropriate experiences (Watson, Nida and Shade, 1986). Rettig (1987) reports accelerated growth in the use of microcomputers in special education preschool programs as well. Goin and Horn (1986) report that much of the instructional software being used with special populations is the same body of software being used in regular preschool programs. As Watson, Chadwick and Brinkley (1986) argue, this is an entirely appropriate practice:

> Current child development theory and most instruction which is developed for the norm group is also generally appropriate for the mildly handicapped. Where one makes allowances is in the instructional application, i.e., lower level and slower pace (p. 203).

The successful use of videodiscs in education is also well documented (Miller, 1987). The videodisc's chief strengths, according to the literature (Char and Newman, 1986) are:

- Superior, high quality visuals of real world phenomena.
- User control over the accessing and displaying of visual images.
- Availability of interactive, problem-solving contexts.

However, little work has been done in the area of videodisc development for preschool audiences. Only two such discs appear to have been designed at this point in time: a demonstration disc developed by Apple Computers in 1987 and a disc on whales developed for six-year-olds by Dr. J. A. Watson at the University of North Carolina. Initial research on the Watson disc (Watson, 1989) showed that students in two experimental situations using the videodisc learned significantly more than children in the control situation in which a teacher taught the same material included on the videodisc through a text. Thus, the state of the art reveals a dearth of concrete research but a strong indication from experts that the use of technology holds much promise in teaching handicapped preschoolers.

II. Purpose

The overall purpose of this study was to ascertain the appropriateness and viability of developing a videodisc to teach beginning math and science concepts to mildly cognitively impaired preschoolers. This innovative approach to instruction has focused on the use of the technologies of video and graphics to present abstract concepts to children in a concrete manner, appropriate to their developmental ages and skill levels. The information gathered during Phase I through research, telephone interviews, and consultation with design experts has set the stage for full scale development during Phase II.

III. Funding Source

Funding for the Phase I feasibility study has been sponsored by the U.S. Department of Education, Office of Special Education Programs (OSEP), through the Small Business Innovation Research (SBIR) program. A renewal of the contract for Phase II will enable the design plan created under Phase I to be implemented.

IV. Phase I Objectives

Phase I activities focused on exploring the viability of this product. Four objectives were set for this phase:

1. To investigate the specific experiential needs of young (ages 3 to 5) handicapped children in the areas of math and science.

2. To develop a preliminary design for a videodisc to use in early childhood programs for handicapped children.

3. To assess the capabilities of videodisc technology to meet these needs with particular focus on the use of touch screen technology, voice technology and/or voice recognition.

4. To prepare a design document for this technology project.

V. Summary of Phase I Accomplishments

Toward meeting the Phase I objectives, Macro has successfully accomplished the following:

- Identified, reviewed, and analyzed cognizant literature pertaining to the use of computers with preschool children, videodisc instruction, the teaching of preschool math and science, with emphasis on the use of technology and instruction with mildly cognitively handicapped children.

- Identified and interviewed at length recognized experts in the fields of preschool math and science, preschool special education, and the use of technology with preschool children.

- Reviewed existing software, videodisc, CD-ROM, and hypermedia products developed for preschool audiences.

- Obtained support from the computer industry to assist in Phase II. A letter from IBM Corporation, reflecting this support appears in Appendix A.

- Enlisted the support of potential publishers of the videodisc in anticipation of Phase II funds. Letters reflecting this support are included in Appendix B.

In the following chapter, we describe those activities that led to the accomplishment of the milestones noted here.

Chapter II. Phase I Activities

The first initiative undertaken under this SBIR contract was to investigate the specific learning needs of preschool handicapped children. Four activities were conducted in association with this task:

- Specifying the target audience.
- Reviewing written literature on topics relevant to Phase I, i.e., the use of technology with preschoolers, the use of technology in special education, math and science education for preschoolers, and math and science special education.
- Identifying and interviewing experts in the fields of preschool special education, preschool math and science, and preschool technology on issues related to content and design.
- Reviewing existing math and science technology currently available to preschool audiences.

Following this, four additional activities were carried out in fulfillment of the project's objectives:

- A review of hardware and software for the proposed videodisc.
- The attainment of support for Phase II from IBM and potential publishers.
- A meeting of the Design Team during which the results of earlier tasks were discussed and used as a basis for project decisionmaking.
- The development of a design document for the proposed videodisc.

Each of these activities will be summarized in turn.

I. Target Audience Specification

As a first step in project, the Design Team felt the need to define the target audience with greater specificity than had been set forth in the SBIR Phase I proposal. Originally, our target audience was noted only as "preschool handicapped children ages 3 to 5." However, to develop materials that are truly developmentally appropriate for children's cognitive, socio-emotional, and physical growth, it was felt that the characteristics of the target audience needed to be better known. For this reason, the design team specified the target audience as being "mildly cognitively impaired children, ages 3 to 5." This audience was selected for several prime reasons. First of all, this population represents in numbers the

largest grouping of handicapped children. Further, because children with developmental delays are most likely to be mainstreamed by regular preschool programming, such as the Head Start or military sponsored programming, they are most likely to have access to the finished videodisc. In addition, there are a great many preschool children who have not been identified as mildly cognitively impaired, but who do, in fact, suffer from developmental delays. It is these children who are "at risk" that we also wish to include in our target audience.

Having identified our target audience, from this point, all design considerations were based on the known learning and instructional needs of these children.

II. Literature Review

The literature review covered a number of key areas relevant to the proposed effort:

- young children and computers
- using microcomputers to teach preschool math and science
- using microcomputers in early childhood special education
- using videodiscs with children
- teaching science and math concepts in the preschool
- adapting preschool math and science for special education.

Resources from the ERIC system, the Library of Congress, the libraries of the University of Maryland and the George Washington University, and from the personal files of members of the design team were consulted.

As summarized in the review (see Appendix C), the following key conclusions were drawn from the literature that will likely affect the proposed math and science videodisc for mildly cognitively impaired preschoolers:

1. Hard effectiveness data on learning by young children through computers is sparse. Moreover, the inappropriateness of designs employed by many studies and the lack of longitudinal data have been cited as ongoing research problems. Most research data concentrate on social behaviors and effective ways to use computers. Studies have indicated that young children are motivated to use computers, that children learn best when the teacher serves as a "facilitator," that computers do not isolate users, and that young children can readily master hardware and software.

2. Most research on young children and computers points to the "potential" of computers to teach. As Clements (1987) summarized in his review of research literature, "Young children do not need computers any more than they 'need' any of the many potentially valuable learning centers. There is, however, nothing to lose and potentially rich benefits to acquire through informed use of computers." (p. 42)

3. There are currently over 350 software programs available for preschool children; 121 of these are in the areas of math and science, with the majority of these focusing on counting and shape recognition. The developmental appropriateness of commercial software in general has been strongly questioned in the literature.

4. While there is a dearth of research on the use of computers in early childhood special education programs, experts have singled out the management and instructional potential of software as a benefit for early childhood special education programs.

5. Videodiscs have been successfully used in postsecondary and secondary education environments to teach science and other subjects. The only known research study (Watson, 1989) involving preschoolers (i.e., kindergarten students) found that experimental classes, where teachers used a videodisc to teach children about whales, yielded significantly higher learning scores than the control classrooms where teachers taught from a text.

6. Preschool math is taught from a variety of theoretical frameworks. Most support in the literature is for a Piagetian-based approach in which children are taught preconservation skills such as patterning, classification, seriation, and numeration. (The *High/Scope Cognitively Oriented Curriculum* and *Mathematics Their Way* were highlighted as examples of curricula using a Piagetian framework.)

7. Science education is a more recent addition to the preschool curriculum. Those programs that use an integrated approach primarily focus on Piagetian concepts such as spatial relations, classification, and time.

8. Research in early childhood special education supports the use of a developmental approach to instruction, which is Piagetian-based. Delayed learners are encouraged to progress at their own pace.

9. Early childhood special education programs focus on the same cognitive goals as regular preschool programs: classification, sorting and matching; seriation; color; shape; space; time; opposites; and letters.

10. Accommodations for teaching mildly cognitively impaired learners the Piagetian-based concepts listed above have been put forth by special educators, such as Cook, Tessier, and Armbruster (1987) and Rowbury (1982).

III. Interviews

As a supplement to reviewing the documented literature, a series of telephone interviews was conducted with recognized experts in the fields of early childhood education, special education, technology, and preschool math and science instruction. Through these interviews, we sought to obtain the following:

- Information on the most current (i.e., ongoing) research in this newly explored area (including unpublished data, research reports, journal articles, etc.);
- Subjective as well as objective data on what the experts regard as the best avenues to pursue during development; and,
- Ongoing, working relationships with the recognized leaders in these areas.

A total of 13 individuals representing each of the targeted domains was identified; all agreed to participate in a 1 to 2 hour telephone interview. Ultimately, only 8 of the 13 experts were available to participate in this effort. The backgrounds represented by these experts are shown in the matrix below.

EXPERT INTERVIEWED	EARLY CHILDHOOD EDUCATION	SPECIAL EDUCATION	COMPUTER SOFTWARE TECHNOLOGY	VIDEODISC TECHNOLOGY	MATH AND SCIENCE EDUCATION	RESEARCH/UNIVERSITY AFFILIATION	CLASSROOM TEACHER/PRACTITIONER	GOVERNMENT/POLICY
Buckleitner	●		●		●	●	●	
Davidson	●	●	●		●	●	●	
Haugland	●	●	●		●	●		
Hebbeler	●	●	●		●			●
Morissey	●	●						●
Shade	●		●			●		
Watson	●	●	●	●	●	●		
Wolfinger	●				●	●	●	

Figure 1. Specialty Areas Represented by Experts

An average of 1.5 to 2 hours was spent with each expert. Experts were asked to react to 15 specific questions regarding the proposed content and design for the videodisc. A copy of the telephone survey instrument appears as Appendix D. Experts were also asked for

additional comments and suggestions; seven of the eight interviewees provided extended comments.

The conduct of the interviews, while structured to capture information on all of the target questions, was flexible enough to allow the interviewees to expand on those areas of particular interest to them. In this way, we were able to learn much about ongoing research as well as the state of the art. In addition, we were able to obtain on-the-spot reactions from the experts to particular ideas and approaches under consideration.

The results of the telephone interviews are summarized in Appendix C. In Appendix E, copies of the individual interviews are included. The following generalizations can be drawn from the expert interviews as a group:

- Research on computer software and young children is felt to be applicable to videodiscs. In particular, child control and ongoing interaction have been singled out as crucial for success.

- The target audience can be expected to sit at a computer screen for approximately 10 minutes at a time. Individual differences, particularly learning style, will affect attention.

- Interest in the videodisc can be maximized by making the program highly interactive and giving the child control.

- There should be a balance between computer graphics and video portions. Since interaction is rooted in the computer graphics segments, technology experts feel that the balance should be tilted toward computer graphics.

- Animation is recommended.

- Written labels are recommended, although their benefits are questioned by several experts.

- Technology experts feel that children should be allowed to progress through a program to as high a level as possible without stopping. Those without a technology background recommend presenting all children with alternative learning strategies.

- Recordkeeping is favored by the majority of experts, especially as a management tool for the teacher. It is felt that attention and learning curve data are important to track.

- The teacher should serve as a facilitator and diagnostician; he or she should allow the child to interact with the machine on his or her own.

- Math and science concepts should be integrated in the videodisc.

- A Piagetian approach to content should be used. Concepts such as patterning, classification, and seriation--which are applicable to both premath and prescience--are endorsed.

IV. Product Review

The final prong of background research conducted for the Phase I feasibility study was an examination of existing software, videodiscs, CD-ROM, and hypermedia products targeted at a preschool audience. Products for this review came from three primary sources:

- The Department of Education's Office of Educational Research and Innovation (OERI) Technical Library

- *The Educational Software Selector (TESS)* published by EPIE Institute (1988)

- *Survey of Early Childhood Software* published by High/Scope Press (1989).

Only one videodisc developed for preschoolers was identified: a disc for 6-year-olds on whales, developed by James Watson, one of the eight experts interviewed under this contract. Another videodisc for preschoolers, developed by Apple Computers, was no longer available for viewing. In comparison, 121 software computer programs were identified for this audience in the fields of math and science alone. In the area of math, most programs concentrated on shape recognition and counting. Science software, which is produced in smaller frequency than math software, tended to focus on specific topics, rather than basic functions. Gardening, the weather, and pollution were popular software subjects. An overview of the products reviewed by project staff appears in Appendix C.

V. Hardware and Software Review

Interactive videodisc has certain inherent qualities which have made it particularly attractive to educators for over a decade. These include:

- The capability of full interactivity equivalent to that in the best traditional computer assisted instruction (CAI) programs,

- The ability to present real world images in both full motion and still form,

- The capability to provide realistic sound rather than robotic speech through access to dual audio tracks, and

- The ability to combine text and graphics from the computer program with photographic quality images from the videodisc itself.

However, there is a range of capabilities in currently available videodisc delivery hardware and in development software. There is no perfect option suited to all situations. Rather, in each case, a decision must be made for the particular audience and the particular type of application being developed. This decision is complicated by the rapid pace of change in this field. New and more powerful hardware and development tools are becoming available at an accelerated rate. Thus, in order to make an appropriate decision about the delivery system and development hardware, a review of available technology products for both delivery and development of interactive videodisc was a necessary part of this feasibility study.

During the development of our design, it became apparent that the following were important features of the delivery hardware and development software for a videodisc targeted at mildly mentally handicapped preschool children:

- Ability to present all images, both graphic and video on a single screen.
- Intuitive and durable user interface
- Ability to easily generate and incorporate realistic graphic images into the program
- Ability to easily develop and incorporate appropriate animation.

Decisions about authoring software and delivery hardware are intimately connected. The decision about one cannot be made without consideration of the capabilities of the other. Below is a brief summary of the decision making process used during this project.

A. Hardware

We gave consideration to both Apple Macintosh and IBM PC/XT/AT and compatibles and PS/2 models, both with and without the InfoWindow touch screen monitor. We limited our consideration to products of these two companies because these are the most widely accepted and available computers in the United States. We felt that it would be most appropriate to develop our product for a system which is relatively widely available now and shows promise of being a leader in the near future.

Both modular Macintosh computers (e.g. Macintosh II/IIx/IIcx/IIci) and IBM AT and PS/2 models can support digital video using a digital video adaptor card. These cards with an appropriate monitor allow the presentation of video, text, and graphics on a single screen. However, the quality of digital video images is noticeably lower than the quality of analog video images. We were particularly interested in presenting clear, high quality images to our audience. Therefore, we decided that the state of the art in digital video was not yet advanced enough for this particular project.

We briefly considered two screen systems, which also can be set up with either Apple Macintosh or IBM AT and PS/2 computers, but quickly concluded that such a system would be unmanageable for our audience. We felt that we needed a single screen system along with the capability of presenting high quality video images.

In addition, although we had evidence from the literature and from interviews with experts (Shade, 1989; Watson, 1989) that even preschool children find working with a mouse relatively easy, we felt that a touch screen interface would be superior for this application. A touch screen would make it possible to come very close to the actual physical manipulation of objects in sorting tasks. A number of touch screen monitors or "heads" are available, including the Sony View system and the Visage system. However, the IBM InfoWindow is currently the industry leader, and in fact, most other DOS based systems currently advertise their products as being "InfoWindow compatible." As a result, we have decided that the videodisc envisioned for this project lends itself best to the IBM InfoWindow system.

B. Software

We had initially thought that a hypermedia programming tool such as *Hypercard* for the Macintosh or *Linkway* for IBM PC/XT/AT and compatibles might be appropriate. However, upon further investigation, it was decided that hypermedia environments can be confusing, and are really most appropriate for learners who are self-directed and have already acquired basic knowledge of the area on which the program focuses. While hypermedia environments have great potential, particularly for sophisticated learners, we felt that a somewhat more structured learning environment was more appropriate for our target audience.

Looking at more traditional authoring systems and languages, we considered *Pilot for the IBM InfoWindow, TenCORE, IconAuthor,* and *Course of Action.* We concluded that *Pilot* was not a powerful enough language to support our design. *Course of Action* is a Macintosh development program, although there are some capabilities for porting programs developed with it over to AT and PS/2 systems.

At this point, we are still considering whether to use *TenCORE* or *IconAuthor* as the development tool for this project. Each has its own advantages and disadvantages. *TenCORE* is a true authoring *language*, a powerful and flexible tool for courseware development. In addition, four members of the project staff are experienced in working with this language, having used it to develop the OSEP-funded *Working With Math* interactive videodisc. Using this software, it is possible to do almost anything for which there is a need based on the instructional design. However, this freedom has a price--the amount of time required to develop courseware with *TenCORE.* We believe that the icon-based authoring *system IconAuthor* may have sufficient power for the development of this application. If so, its exceptional ease of use would make for efficient development of this interactive videodisc program. In addition, *IconAuthor* has the capability of handling animation very easily, while

animating in *TenCORE* is somewhat complex. Since we anticipate a considerable use of animation in this program, this capability is a significant advantage. We will carefully weigh these advantages and disadvantages as the design develops further and make a final decision with the input of our Design Team during Phase II.

VI. Industry Support

In order to have an impact in the educational arena and achieve the goals inherent in the funding of SBIR contracts, developed products must reach the market place in commercially available form. In the case of specialized delivery systems, such as an interactive videodisc with touch screen interface proposed for development in Phase II of this SBIR, it is beneficial and cost-effective to solicit support for necessary development hardware and software. In addition, it is clearly important to ascertain the interest of those software publishers who might potentially become distributors of the software resulting from a Phase II SBIR production.

Early in Phase I, Macro staff contacted the IBM Corporation, which expressed high interest in the development of this interactive videodisc product targeted at preschool mildly handicapped children. IBM has agreed to provide at least one complete InfoWindow system, including computer and videodisc player, to be used in the development of this preschool math and science program. Further, IBM concurred with us that pilot testing prototype products is an important step in the whole development process. Since interactive videodisc equipment is not yet readily available in most public schools, child care facilities, and other preschool programs, IBM has agreed to provide at least six complete InfoWindow systems to be used at field sites for pilot testing purposes. IBM's letter of support is presented in Appendix A.

Macro staff also contacted five software publishers, who were asked to indicate the level of interest they would have in the proposed interactive videodisc product. Although all five publishers were very interested in the developmental approach to preschool math and science that we will be using during product development, none of the publishers would be willing to advance funds for this development. Inquiry regarding a completed product, though, produced an entirely different response: four publishers expressed positive projections about the market potential for this product, particularly in Head Start programs. These four publishers asked for updates on progress of the product if Phase II funding is approved, and they indicated interest in reviewing the final product for possible publication. Publishers' letters of support are contained in Appendix B. It is the feeling of these publishers that growth of interactive videodisc hardware and use in public education is certainly likely to follow paths set by private industry, the military, and other federal agencies.

VII. Design Team Meeting

The Design team consisted of the following individuals:

- Dr. Louise Appell, Macro Systems
- Ms. Ellen Bialo, Interactive Educational Systems Design
- Dr. Laura Colker, Macro Systems
- Dr. Carolyn Harris, Macro Systems
- Mr. David Hopwood, Video Software Associates
- Ms. Elaine Robey, Macro Systems

Also in attendance at the Design Team meeting convened on December 18, 1989, was the contract Project Officer, Ms. Jane Hauser. Dr. Linda Tsantis of IBM was unable to attend.

Prior to the meeting, all members of the Design Team were forwarded copies of the Literature Review, The Summary of Expert Interviews, and the Software Product Review, in addition to the proposed agenda.

As a group, participants felt that the Literature Review provided an appropriate frame of reference for development. Several participants, however, felt the need to underscore that research data are lacking, particularly in the area of longitudinal studies.

In general, the Design Team concurred with the advice offered by the experts during the telephone interviews. In those cases where expert opinions were not in consensus, the Design Team made recommendations, including the following:

- Animation is important to include when it is educationally appropriate.
- Written labels should be used. However, the ability to read the labels should not be a prerequisite for using the program.
- All children should be presented with many representations of the same concept, in order to facilitate learning.
- Recordkeeping was thought to be a costly investment that should only be incorporated if gatekeepers would react negatively to its not being included.
- The Piagetian constructs of classification followed by seriation were judged to be the most important topics to teach children since these provide the framework for the acquisition of math and science knowledge.

A full overview of the Design Team meeting appears as Appendix F.

VII. Preliminary Design Document

In conjunction with the Design Team meeting, an initial plan for the design of the videodisc was laid out. There was group agreement that the videodisc be perceived as an umbrella for helping students employ the scientific method to acquire math and science concepts. By observing and exploring data, children would learn to classify data, order it, and display information in simple formats. The specifics of the design plan are described in the next chapter.

Chapter III. Design Plan

The culminating activity for Phase I was the specification of a plan for design of the videodisc. This plan was based on the findings of the literature review, the expert interviews, the product review and consultations with the Design Team, already described in Chapter II. The specific components of the design plan are outlined here.

I. Target Audience

As noted in the preceding chapter, one of the first steps in the creation of the design plan was to narrow the audience so that we could customize the videodisc to the needs and characteristics of a particular user population. With this in mind, we chose to focus on mildly cognitively impaired preschoolers. This audience was selected both because it represents in numbers the largest percentage of handicapped children and because it also allows us to reach "at risk" preschoolers who may, in fact be developmentally delayed, but have not been so identified.

Other than being developmentally delayed, our target audience will in all other ways be representative of three to five year olds as a group.

II. Educational Principles

At the backbone of the design plan are those educational principles that characterize the user audience. As developers, it is incumbent upon us to know how the children in our target audience learn best, what their learning habits are likely to be, and how they interact with each other and as a group. Knowing this, we can thus customize the videodisc to motivate these children to learn.

Physical characteristics of the target audience:

- whirlwinds of energy
- enjoy using their developing large muscle skills: hopping, jumping, running, and skipping
- able to control their fine muscles: tearing paper, using a scissors, holding a paint brush and manipulating a computer mouse.
- increasingly able to refine their eye-hand coordination: stringing beads, zipping a jacket, and pushing a computer key they have in mind.
- able to show improved balance and coordination skills over time.

Socio-emotional characteristics of the target audience:

- take pride in their accomplishments
- look for approval from their parents and teachers

- younger preschool children like parallel play; older preschool children enjoy cooperative play
- younger preschool children have difficulty sharing
- respond well to praise and encouragement
- impulsive.

Learning characteristics of the target audience:

- tend to focus on one aspect of the environment at a time
- "time on task" varies, but about 10 minutes on the average
- learn through concrete interactions with the environment
- need learning environment to be structured to make up for delays in attention, concentration and perception
- need "active" learning experiences
- need to experience cause and effect
- need lots of repetition for learning to take place
- may need help in beginning a task, staying with it and recognizing when it is completed
- may need to have cognitive skills to be learned broken down into smaller, sequenced steps
- motivation for learning stimulated when they feel responsible for their own success
- need to be able to manipulate their learning environment
- learn best when learning materials are within their reach and at their eye level
- learning is maximized when there is freedom from fear of failure
- encouragement is essential to learning.

Other cognitive characteristics of the target audience:

- enjoy games
- enjoy fantasy, imagination
- egocentric--think everyone behaves and acts as they do.

III. Design Principles

By knowing how developmentally delayed children act in a learning environment, we can create materials for them that will accommodate their needs, tap into their interests, and help them to learn. The following features should characterize the proposed videodisc if it is to meet this challenge:

- **Highly Interactive** - The child will be an active participant in the learning process.
- **Child Controlled** - The child will be able to select environments of his or her choice, decide whether or not he or she wants to continue doing exercises, decide which skill activity to work on, etc.
- **Built-in Escape Feature** - At any time the child will be able to exit the program.
- **Screens Don't Fade Out Completely** - The child will not be in a position of deciding what to do next.
- **Realistic Graphics** - To help the pre-operational child assimilate information, concrete representations will be provided.
- **Animation Included** - Since children respond positively to animation, this will be included where appropriate.
- **Age-Appropriate Vocabulary Used** - To maximize use, the narrator will speak to the child in terms he or she understands. This does not, however, imply that the speaker will condescend to the child.
- **Written Labels Included** - To help a child develop sign recognition, appropriate objects will be labeled. However, at no time will the child need to be able to read these labels to operate the program.
- **Content Reinforced** - Since reinforcement is critical to learning, the child will be presented with a variety of learning opportunities for exploring concepts.
- **Content Presented Sequentially** - Because children learn best when content is broken down into manageable bits of information, the program will walk the child through a learning hierarchy.
- **Content Focused on One Aspect of Learning at a Time** - Since young children can attend to only one aspect of learning at a time, activities will be geared to teach a child specific topics such as sorting by one attribute or determining which object in a grouping is different from the others.
- **The Program Will be Linked to Classroom Learning** - Because the videodisc is just one of the learning centers in the preschool classroom, the content presented here will support, reinforce, and elaborate on learning objectives being taught elsewhere in the classroom (e.g., with blocks, table tops, art, etc.).

IV. Content

From initial research and conversations with the expert panel, two main decisions concerning content were reached:

1. Math and science skills should be combined rather than separated; and,

2. A Piagetian framework should be used as a basis for presenting content.

Given this directive, the Design Team considered several Piagetian concepts that could be used to convey both math and science: classification, seriation, number and time, among others. In response to our belief that it would be best to concentrate on one--at most two--concepts if we wish to teach a concept in-depth rather than just provide an overview, it was decided to concentrate on the concept of classification since this concept is basic to all later learning and one which every preschooler must master in order to do math and science.

V. Products

This interactive videodisc will be primarily tutorial in nature. The tutorial approach will benefit from the realism possible in the medium by modeling skills associated with classification and through the use of familiar real-world objects. The student will learn the skills and concepts essential for classification and will have opportunities to use these skills and to consolidate concepts in structured activities. In addition, there will be opportunities provided for the creation and use of classification systems invented by the child. Product components will include:

- A single-sided 12 inch videodisc which contains full motion video, still video images, and all narration and direction. The capacity of a single-sided videodisc is one-half hour of moving video, and two half hour audio tracks for a total capacity of one hour's audio.

- Floppy disks (both 3 1/2 and 5 1/4 inch) containing the program which directs the course of the videodisc, supplementary graphics, and the teacher utility program.

- Documentation explaining hardware requirements, installation of the program, entry into and operation of the program, content coverage and approach, and supplementary activities which may be used to reinforce the classification activities on the disc.

VI. Design Components

A. Program Structure

The program will have four environments in which the child can observe and explore while developing concepts and practicing skills related to classification. These four environments are:

A Nature Walk — Taking the child from the house to a nearby park. Classification activities will make use of plants, animals, and inanimate objects commonly encountered in neighborhoods and parks.

A Trip to a Farm — Including sights that might be encountered on a drive to or in the country. Classification activities will focus on farm animals, wild animals generally encountered only in rural areas (e.g., deer), crop plants, and common farm implements.

An Ocean Holiday — Including a walk along the shore and underwater sights. Classification activities will focus on objects commonly found on the shore (e.g., shells, seaweed, manmade objects) and those found under water (e.g., fish, coral, jellyfish, etc.).

A Trip to the Zoo — Including sights that would be encountered on the way to a city zoo. Classification activities will focus on transportation vehicles, building shapes and characteristics, and zoo animals.

Within each of these environments, there will be at least two "strands" that the child can follow. For example, the Ocean Holiday environment will have a "beach walk" strand and a "looking under the water" strand. Children will be exposed to activities related to each of the major educational objectives (specified below) in each of the four environments and in each strand. This will encourage generalization and transfer of skills as well as provide preschool teachers with a convenient informal assessment tool to determine if such transfer and generalization has taken place.

It is anticipated that this videodisc will teach a hierarchy of classification skills to young mildly mentally handicapped children in a format which is fun and highly motivating. By presenting real life environments that provide opportunities for observation of plants, animals, and inanimate objects, the principles of classification and the excitement of scientific investigation will come alive for these children.

B. Content

As currently envisioned, a hierarchy of nine classification skills will be taught through use of this videodisc program. They are:

- Classifying by identity (e.g., shells, fish)
- Labeling according to identity whether an object "is" or "is not" a member of a group (e.g., *is* a shell, *is not* a shell)
- Sorting by identity (e.g., moving all of the shells on the beach into one basket, all the rocks into another)
- Classifying by one attribute (e.g., size, shape, or color)
- Labeling according to one attribute whether a object "is" or "is not" a member of a group (e.g., is a round shell, isn't a round shell)
- Sorting by one attribute (e.g., putting all the pink shells into one basket, all the white shells into another)
- Classifying by two attributes (e.g., size and shape, color and size, shape and color, etc.)
- Labeling according to two attributes whether an object "is" or "is not" a member of a group (e.g., *is* a round pink shell, *is not* a round pink shell)
- Sorting by two attributes (e.g., putting all the round pink shells into one basket, all the other shells into another)

Children using the program will have considerable opportunity to work on each of these nine major skills. They will be able to continue working on the same skill for as long as they wish, using various objects from the environment in which they are working. While most of the time they will be working on a classification task for which there is an objectively measurable correct response, children will also have the opportunity to sort using categories of their own creation, much as they would do if they were playing with blocks or table toys on their own.

Learning to sort concrete objects by identity, by a single attribute and by two attributes are complex tasks for young children. Therefore, sorting activities at various levels of

difficulty will be developed for each of these major objectives. We envision that there will be at least three levels of sorting activities:

(1) Forming two discrete groups of objects from a single large group (e.g. putting the pink shells in one basket and the black shells in another)

(2) Forming three discrete groups of objects from a single large group (e.g. putting the pink, black, and white shells in three color-coded baskets)

(3) Open-ended activities in which children sort according to classification schemes of their own design (e.g. all the shells with smooth edges, all the shells with jagged edges)

C. Activities Overview

The activities and the sequence of presentation in each environment will be similar. This will give the child incentive to practice each skill many times, and will also provide opportunities for the child to understand that the skill is generalizable and transferable to many settings and circumstances.

For each skill and subskill, a defined number of directed practice opportunities with feedback will be provided. This number will vary within the program depending upon the complexity of the skill and the concepts involved. However, following the required practice set, the narrator will ask if the child wishes to continue working on this activity or go on. Additional practice will be available for those who select it.

Open-ended sorting activities, in which the child will select the attribute or attributes to be used for sorting, will also be available in each environment. In these activities, the child will be able to move objects into as many groupings as desired. Because this is open-ended, and so cannot be judged right or wrong, no feedback as to the correctness of the child's actions will be given. However, an animated character will ask if the child wants to try another independent classification activity when the child indicates a desire to go on.

D. Instructional Approach

As stated earlier, the anticipated program will be tutorial in nature. Once the educational objectives are finalized by the Design Team, activities will be tightly structured and clearly focused. Explicit instruction will be provided to introduce and reinforce skills and concepts related to classification.

To illustrate our approach, consider the objective of teaching children observation skills. Observation is essential to classification. Without careful observation of important attributes, consistent classification is impossible. Children are often limited

in the attributes which they notice by the perceptual salience of the attribute. In this program, specific efforts will be made to widen the range of attributes which the child observes, by describing objects carefully and in detail as well as by explicit instruction that objects may be classified on any of their attributes, not just the most obvious ones. A wide range of attributes will be covered in the structured activities, and the open-ended activities will provide opportunities for the child to be creative in recognizing and using the attributes of objects.

E. Feedback

In most cases, the child will be given feedback as to whether or not he or she has carried out the activity correctly, although, as mentioned above, there will also be opportunities for open-ended trials. Positive feedback will be given in the form of graphics, such as an animated character clapping hands, a rainbow arching across the screen, or twinkling stars placed by random generation. Incorrect feedback will be very supportive, and will make use of an animated character. Visual incorrect feedback will also be provided for some sorting activities. For example, a shell placed in the wrong basket will pop back out. The child will be prompted to look at the object carefully and to try again.

F. Program Control

It is anticipated that the program will operate in two modes -- entirely under student control and, through the use of a teacher utility, focused on certain objectives with limited student control over movement within the program.

When operating entirely under student control, the child will always have the opportunity to exit the environment, to select a new environment, to go back to a previous activity, or to move forward to another activity. Forward and backward movement will be accomplished by a graphic map of the environment strand on which the student is working. This simple map will show where the child has been during this session and the child's current location. By touching a place on the map, the child will be able to jump to that part of the program. Context sensitive help will also be available at all times, in case the child becomes confused about what to do on a particular activity. Thus, at all times when the program is operating in student mode, the child will have access to help, an escape hatch, and a map which allows free forward and backward movement within the environment.

When the teacher utility is enabled, the teacher will be able to select the activity on which the child will work. For instance, the teacher could choose to have the student work on sorting by a single attribute in the beach walk strand. In this mode the child would only be able to move forward within that particular strand. The map

which would permit full student control would not be available to the student. However, the child would still have access to the escape hatch and context sensitive help.

VII. Program Operation

Below is a brief description of the program as it would operate under full student control. The focus here is on what the child will see and the interactions required when working with the program.

A. Introduction

The introduction will be a vivid visual presentation of real world objects in each of the four environments. Full use will be made of the capability of videodisc to present the environments and their objects realistically.

Narration accompanying the pictorial presentation will orient the child to the program and its four environments. Because young children typically look up to and seek to imitate older children, the narrator, who will also act as a guide and model in some motion segments, will be an older child. We believe that this model, exploring the environment with younger children, will be highly believable and motivating to our audience.

Finally, examples of ways that the child will interact with the program will be presented. Although access to information on ways to interact with the program will always be available within the program through the context sensitive help feature, a brief demonstration and some opportunity for practice at the beginning will serve to reassure children that they can do what is required.

B. Main Menu

Following the introduction, a colorful graphic menu will appear. A preliminary conception of how this might look is shown in Figure 2. To help children understand what the images represent, a small animated character, a cartoon version of the older child narrator/model will move around the map, pointing out and describing the various environments, and encouraging them to select an environment by touching it on the map.

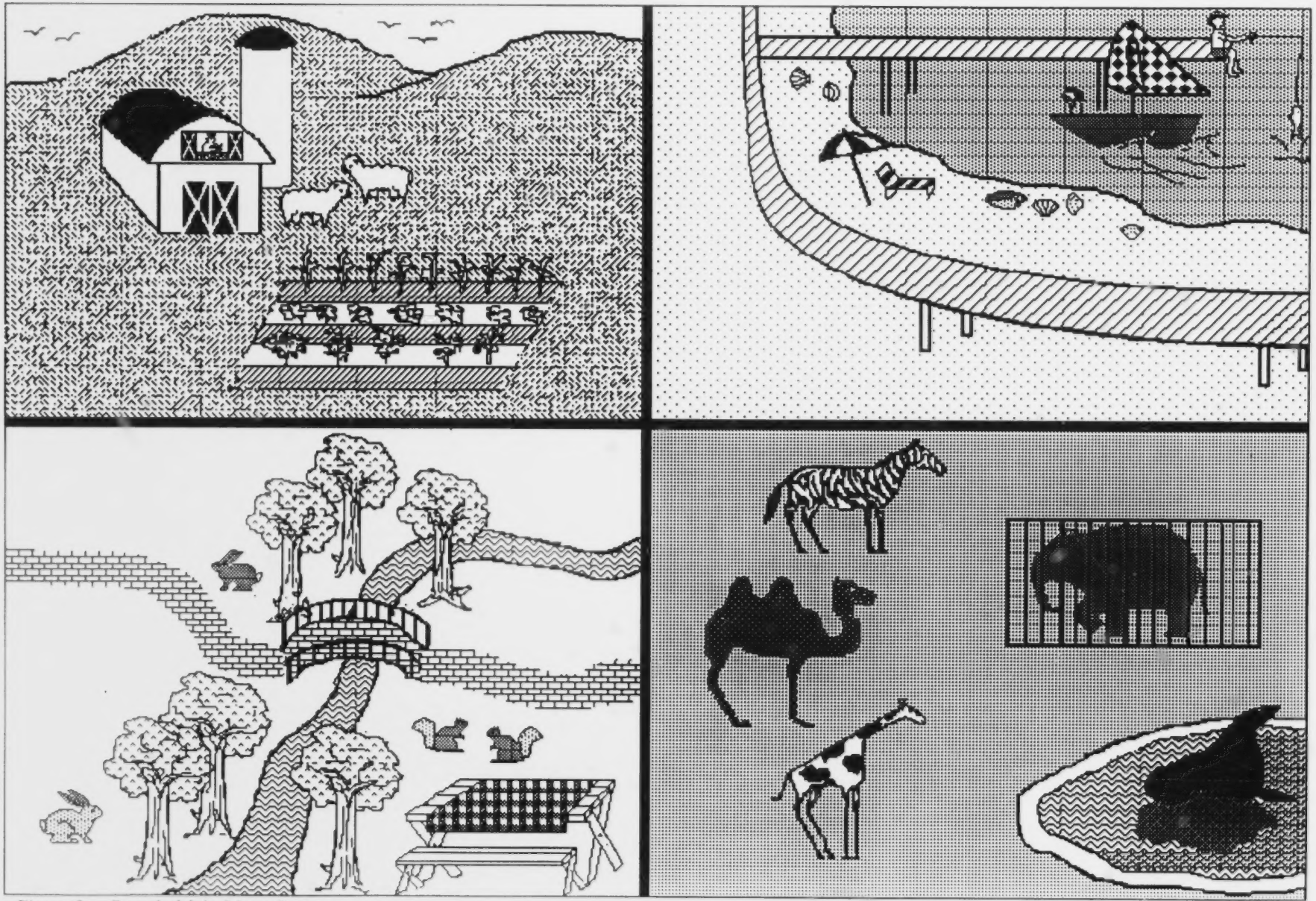

Figure 2. Sample Main Menu Screen

C. Example Environment--Ocean Holiday

If the child selects the Ocean Holiday environment, the gateway into the environment will be a series of beach scene clips (e.g., sea gulls flying, waves crashing, waves washing up on the beach, sand castles eroding, sand crabs crawling, fish swimming, jellyfish floating). Within each environment, the child will be presented with a choice of strands which may be followed within that environment. In the beach environment, the choice will be between two strands:

- Walking along the beach
- Looking under the water.

The child will select one of these options by touching a graphic or video still representation on the screen. Having selected one of the options, a very simple map of that strand will appear. The child will then select a starting point within the strand.

If the child selects the beach walk strand and chooses to start at the beginning, the demonstration of concepts and skills will be presented using the materials of the beach environment. The activities will build from simple to complex, as described above in the *Content* and *Activities Overview* sections.

The first activities will be those which are connected to classification and sorting by identity, the simplest level. However, at any point, the child will be able to access the map and jump ahead to the middle level, or even highest level, activities for the beach walk. These activities will be related to classifying and sorting by a single attribute or classifying and sorting by two attributes.

Of course, the student will be able to quit the strand and the environment at any time, and will also be able to jump forward or go back to a previously encountered activity or explanation. When the child exits an environment, the program will return to the main map which shows all four environments graphically. From here the child may select another environment or leave the station entirely, allowing another child to select an environment and try the activities.

Chapter IV. Conclusion

The underlying purpose of the Phase I SBIR effort was to establish the feasibility of developing an interactive videodisc to teach math and science concepts to preschool handicapped children. Toward this end, Phase I has achieved this goal. Through an extensive literature review, interviews with recognized experts in the areas of preschool technology and math and science early childhood special education, plus consultations with the Design Team, we established the following:

- Technology, in particular, the interactive videodisc, holds much promise as an effective, highly motivating educational tool for mildly cognitively impaired preschoolers;
- Piagetian concepts such as classification and seriation should be the basis for preschool math and science instruction; and,
- The videodisc is an ideal medium for teaching children these skills.

As described in Chapter III of this report, the proposed videodisc provides an exciting avenue for instructing children in basic premath and prescience skills. By allowing children to manipulate *real-world* objects, they can actively acquire concrete knowledge about classification. Moving at their own pace, children will be able to work their way through a hierarchy of nine classification skills. As they acquire these skills, they will also be learning about science-related environments. The program will provide ample opportunities for reinforcement and the attainment of problem-solving skills. And like all quality early childhood educational programs, it will be fully capable of being individualized to each child's specific developmental needs. Children will be encouraged to become responsible for their own learning as they work through this program, guided by nonjudgmental reinforcement. The end result will be learning; the byproduct of this effort will be a realization that learning can also be fun.

Macro Systems enthusiastically approaches Phase II of this effort. We are wholly convinced that we can bring into actualization the videodisc product thoughtfully conceived during Phase I. Toward this end, we have obtained developmental support from IBM and solicited the cooperation of potential publishers' interest in distributing the videodisc (see Appendices A and B). We are convinced that during the Phase II development effort, we can turn into reality a concept which Phase I has shown to be both viable and educationally innovative. We look forward to this challenge.

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Appendix A

Letter of Support from IBM Corporation

Washington Center for Technology in Education
IBM Educational Systems

Suite 501
11300 Rockville Pike
Rockville, MD 20852
(301) 571-1425 FAX (301) 571-1457

April 11, 1990

Dr. Louise S. Appell, Vice President
Macro Systems, Inc.
8630 Fenton Street, Suite 300
Silver Spring, MD 20910

Dear Louise:

I am pleased to learn that Macro is pursuing Phase II funds from the Small Business Innovation Research (SBIR) program for the development of an interactive videodisc product to assist mildly cognitively impaired preschool children in building math and science concepts. As you know, there are currently very few developmentally appropriate interactive computer / videodisc programs for preschool children on the market, however several recent studies validate the effectiveness of multimedia technology in providing appropriate learning experiences for young children and their families. As in many other areas of technology use, special education leads the way, and I believe that your proposed product will be valuable for this population.

Macro's standard product development approach that includes a formative evaluation stage is consistent with the approach which has been taken on IBM study projects in education; we feel that it is very important to promote teacher and student participation and input in the design and development of innovative educational products. Such cooperative arrangements between developers and organizations that provide educational services to youth are essential to the production of materials that meet the intended users' needs and actually work in instructional settings.

If Macro is successful in obtaining the SBIR Phase II funds, I will be pleased to arrange for loan of a complete IBM Multimedia system for the development of the risky behaviors decision making program. Further, when the program is ready for pilot testing, I will assist you in identifying appropriate field test sites which have the necessary equipment installed.

I look forward to a continuing working relationship with you and your staff, and hope that your Phase II application receives approval. Please keep me informed on your progress.

Sincerely,

David D. Keefe, Program Manager

Appendix B

Letters of Support from Potential Publishers

AGS®
American Guidance Service, Inc.
John P. Yackel, President

26 March 1990

Louise S Appell, Ph.D.
Macro Systems, Inc
8630 Fenton Street, Suite 300
Silver Spring MD 20910

Dear Louise

Thanks for sharing your information about the proposed interactive videodisc program for mildly handicapped preschoolers on math and science concepts. The exploratory emphasis of the program with activities that are developmentally appropriate are consistent with the focus of the early childhood product development at AGS. This may be an ideal approach for the target population. However, we would not be able to commit to the funding required for this type of product.

This is an intriguing project and I want very much to keep updated on the progress. Videodisc programs are an area of growing consideration for us at AGS, and I feel certain that there will be interest in reviewing the end product. Please keep in touch.

Sincerely yours

Dorothy Chapman
Vice President
Instructional Materials Publishing

DEC/lrv

DLM Teaching Resources

John P. Starkel, Ph.D.
EDITOR IN CHIEF

April 3, 1990

Dr. Louise Appell
Macro Systems, Inc.
8630 Fenton Street, Suite 300
Silver Spring, MD 20910

Dear Louise,

I am writing to support your quest for further funding to continue the work you have done on an interactive video program for concept development in math and science among preschoolers. This is, of course, a tremendously important area of the total curriculum, and one that should be most applicable to the use of technology.

While the technology for interactive video products does exist, our research does not show that it is in wide use in schools. We do, however, continue to watch the development and application of that technology very carefully. It is because of people like you, who can use non-commercial funding sources for support, that this technological development can continue. With Macro System's proven track-record, I'd hope that you will be allowed to continue your efforts on this project.

We at DLM are most interested in your work. I will be most happy to review your final product. Perhaps by the end of the proposed work period we will have a more complete picture of the use of interactive video technology in our marketplace. Please let me know if I can be of further assistance.

Sincerely,

John P. Starkel, Ph.D.

JPS/lw

A Division of DLM® Inc • One DLM Park • Allen, Texas 75002 • 214/248-6300

3490 LEXINGTON AVENUE NORTH, SAINT PAUL, MINNESOTA 55126-8097 (612) 481-3500

April 9, 1990

Laura J. Colker, Ed. D.
Macro Systems, Inc.
8630 Fenton Street, Suite 300
Silver Spring, MD 20910

Dear Laura:

I was very impressed with your proposed videodisc program for mildly handicapped preschoolers on math and science. Your approach is developmentally appropriate and reaches a crucial age group in learning. Unfortunately, we would not be able to commit any funds toward the development of this product.

As you know, our MECC Etc. (Emerging Technologies in the Classroom) catalog already has a sizeable catalog of videodisc products, and we are interested in continued growth in this technology. Our philosophy is to lead teachers in integrating the latest technological advances into their classrooms. We are not aware of any commercially available videodisc programs for the preschool population in general. We would be very interested in following the progress of your development project and in reviewing the final program for possible publication. Best of luck with this endeavor.

Sincerely,

Melanie Smith

Melanie Smith
Research Analyst
Product Development

Appendix C

Review of the Literature, Expert Interviews and Product Review

Investigation of Interactive Technologies For Early Math and Science Concepts For Preschool Children

A Review of the Literature, Expert Interviews and Product Review

Macro Systems, Inc.
January 1990

Preface

This document is divided into three sections:

I. A Review of the Literature
II. Expert Interviews
III. Product Review

Section I highlights relevant literature pertaining to the key areas of interest for this study:

I. Young Children and Computers
II. The Use of Microcomputers in Teaching Preschool Math and Science
III. The Use of Microcomputers in Early Childhood Special Education
IV. The Use of Videodiscs with Children
V. Teaching Science and Math Concepts in the Preschool
VI. Adapting Preschool Math and Science for Special Education
VII. Conclusions

Section II summarizes the eight expert interviews conducted in preparation for designing the plan for videodisc development. These interviews are presented both in summary form and on individual questionnaires.

Section III is an overview of the 121 math and science software programs currently available for preschoolers. Programs are listed alphabetically by title. Information on the content covered as well as any adjudged ratings are indicated where appropriate.

Section I

A Review of the Literature

I. Young Children and Computers

With the advent of the microcomputer a decade ago, many in the educational community embraced this new technology with great anticipation. In 1985, then Secretary of Education Terrell Bell proclaimed, "Just as the automobile has transformed American society beyond the expectations of its originators," so will the use of microcomputer technology "lead to the transformation of public education" (*Science*, 1985, 244:906). While current statistics released by the Office of Technology Assessment (1988) place the number of computers in U.S. schools at 1.5 million, i.e., 1 for every 30 students, the question of whether or not a transformation of public education has taken place is the subject of much debate in the literature.

There is a large body of data reporting both the pros and cons of microcomputer-based instruction in the schools. However, the vast majority of the reported studies focus on elementary, secondary, and postsecondary instructional settings (Tayman and Malouf, 1984). Relatively little research has been conducted with preschool audiences. This lack of research is directly correlated with the relatively recent advent of microcomputer technology in the preschool setting. In a review of the literature conducted in 1984 (Hungate and Heller), the authors were able to locate only two prior research studies (Perlman, 1976; Piestrup, 1981).

A more exhaustive review conducted by Goodwin, Goodwin, and Garrel in 1986 examined more than 90 articles and research studies on the use of computers by young children. Rettig (1987) added another 60 studies to the Goodwin, Goodwin, and Garrel effort for a combined review of in excess of 150 studies. However, both review efforts seriously questioned the quality of the research data available. In a presented paper (1987), Rettig stated (p. 5):

> The information obtained from reviewing this literature reveals that little information is available on the use of computers...by young children. Of the more than 150 articles, only about 15 or 10% could be said to be good experimental studies. Goodwin, Goodwin, and Garrel reported that they found only five studies conducted with preschoolers that followed a good experimental design. Of the more than 20 studies they identified most were descriptive studies that suffered from poor sampling, analysis, or design.

Nearly all of what is designated as research in this area has been more appropriately termed "speculation" by Rettig, Goodwin et al., and other researchers. The focus of this "speculation" is primarily on either the perceived benefits or detriments of computer-related experiences for this audience. Literature finding positive outcomes points to successes in teaching young children alphabet and number recognition, increases in understanding spatial and symbolic representations, problem-solving skills, and increases in cooperation, self-esteem, and issues related to equity (Blankenship, 1989; Tsantis, Wright, and Thouvenelle, 1989; Shade and

Watson, 1987; Hines, 1983; Swigger, Campbell, and Boyd, 1983; Smithy-Wills, Riley, and Smith, 1982; Swigger and Campbell, 1981; Pappert, 1980). Negative conclusions cited in the literature center on the inappropriateness of computer instruction with children who are cognitively at a preoperational stage of development (Banner and Hill, 1983; Elkind, 1981), plus the inadequacy of hardware, appropriate software and teacher training (*Academic Therapy*, 1983).

The debate has remained essentially unaltered since this issue was covered by *The Washington Post* (p. E5) in 1984:

> [Douglas] Sloan [a professor of history and education at Columbia University Teachers College] believes that children who are exposed to the computer too early may be the real losers, because the narrow, logical way of thinking the computer teaches may stifle young children's imagination and hurt them academically in the long run.
>
> The criticisms raised by Sloan and other critics are valid but greatly overstated, says Kenneth Komoski, executive director of the Educational Products Information Exchange...'For certain kids the computer could stifle creativity. For some youngsters who do not develop social ease, it could be isolating.' But for the vast majority of students, Komoski says, the computer could be a tremendous educational boon...

A recent (1987) review of the literature in this area by Clements raises these same important questions:

> Although questions of the use and effectiveness of computers in education are raised at all levels, these questions are debated most passionately about the early childhood ages (birth through 8). Are young children physically and cognitively ready to use computers? Will such use inhibit their social development? Can computers help build skills or develop problem-solving ability? Which is preferable? Research has not answered these questions definitively.

Yet, despite the tentativeness of the observations reported here, there are a number of conclusions that can be drawn about young children and computers:

- Preschoolers can work with standard keyboards and other parts of the microcomputer configuration. They can switch the computer on and off, remove diskettes properly, follow instructions on four-choice picture menus and change disks as often as three times in a ten minute period (Shade and Watson, 1987).

- Computers can be used to provide developmentally appropriate experiences (Watson, Nida, and Shade, 1986).

- Children most interested in using computers tend to be older, exhibit significantly higher levels of cognitive activity, and are organized and abstract in their free play (Hoover and Austin, 1986). They do not differ from less interested peers in creativity, estimates of social maturity, or social cognitive ability (Johnson, 1985).

- No major differences have been found between the way in which younger and older preschoolers use a computer (Beeson and Williams, 1985).

- With one notable exception (Lipinski, Nida, Shade, and Watson, 1986), the literature reports that girls and boys do not differ in the amount or type of computer use (Hoover and Austin, 1986; Johnson, 1985). This finding stands in contrast to the consistent reporting that by elementary school, there is a heavy dominance of computer use by boys (Clements, 1987). The only distinguishing characteristic linked to gender is the finding that boys prefer computer content that is presented via action and sound effects. However, this preference did not affect children's comprehension of content (Calvert, Watson, Brinkley and Bordeaux, 1989).

- Both boys and girls express favorable attitudes toward the computer (Shrock, et al., 1985). One study (Shade, Nida, Lipinski, and Watson, 1986) found that what children liked most about the computer was having control over it.

- Computer use promotes language development. Preschoolers' language activity, measured as words spoken, per minute, was found by one research group (Muhlstein and Croft, 1986) to be almost twice as high as at any other activity center.

In terms of concrete research, most of the remaining topics explored have dealt with the amount of time spent at the computer, social, and free play choices, teacher assistance required, computer access considerations and software preferences (Rettig, 1987). Each of these topics will be briefly reviewed, in turn.

A. Time at Computer

Research indicates that time spent at a computer depends on the child's age, the type of software being used, how prepared the child was for the presentation, and the child's style of learning (Buckleitner, 1989; Haugland, 1989; Shade, 1989; Rettig, 1987). Fazio and Reith (1986) found children spending an average of 6 minutes at one sitting.

Buckleitner (1989a) reports somewhat longer attention spans: up to 10 minutes for three year olds, 10 to 15 minutes for four year olds, and up to 30 minutes for five year olds. Haugland (1989) reports a weekly average of 23 minutes at the computer for three to five year olds.

B. Social and Free Play Choices

Contrary to common preconceptions, computer usage does not isolate children (Rettig, 1987). Research by Haugland (1989) and Shade (1989) indicates quite the opposite: Shade reports that preschoolers enjoy working in pairs and Haugland observes that children at the computer regularly discuss what they are doing with nonusers. Shade and Watson (1987) also report that children using the computer exhibit "mostly prosocial behaviors (turn-taking, helping, sharing)." In general, researchers report that children regard the computer much as they do any other interest area in the classroom. Rettig (1987) concludes that "other play activities in a classroom, such as block or dramatic play activities, still seem to be more popular than computer activities" (p. 7).

C. Teacher Interaction

Research is consistent that children are more involved and interested in computers when a teacher is present (Rettig, 1987). Children themselves, when questioned, expressed a preference for working at a computer under their teacher's direction (Shade, Nida, Lipinsky, and Watson, 1986). Shade (1989) has cautioned, though, that the teacher needs to be a facilitator, not a director of action. He describes the ideal teacher as providing "enlightened guidance."

D. Computer Access

Shade (1989) and Haugland (1989) report that children's interest in a computer is increased when the computer is centrally located in the classroom. Shade (1989) reports that preschoolers are capable of using a mouse; a joystick is too large for young children. Shade (1989) also found that use of the mouse was optimized when the peripheral was "dressed" to resemble a real mouse, with felt ears and a tail. This enabled the children to readily keep the mouse in correct position (i.e., facing them) for ease-of-use. Rettig (1987) examined four modes of input: keyboard, keyboard with adaptor, light pen, and hand paddles. The results of this study showed the keyboard to be the least effective method of input; however, none of the other methods showed superiority over the other. Informal research also reported by Rettig (1987) indicated that "touch screen input methods would be the most appropriate for young children to use" (p. 9).

E. Computer Software

The last several years have produced an abundance of software available for young children. The latest (1989) edition of the High/Scope Survey of Early Childhood Software (Buckleitner, 1989b) includes 355 computer programs for children ages three to six. Experts, however, are quick to point out that quantity and quality are not necessarily synonymous. As Rettig (1987, p. 10) puts it:

> In short, although there are many software programs available in the market, I would suggest that many of these programs have been developed without an adequate research base. In many cases software developers have developed programs with little understanding of what young children can and cannot do. Further, I would suggest that many software developers have developed programs without a clear understanding of what features will enhance the quality and usefulness of the program.

Haugland (1989) believes that one of the more serious problems in the field is that many developmentally inappropriate pieces of software are popular because they are "glitzy." They continue to be used despite their unsuitability because they are fun to use. She cites several examples of publishers who are unwilling to remove software that is inappropriate from the market because they are money-makers.

To be most appropriate, researchers such as Shade (1988; 1989), Haugland (1988; 1989), and Buckleitner (1989) feel that software should share these characteristics:

- Be age appropriate
- Be child-centered, i.e., interactive
- Be quick moving, i.e., no downtime
- Be icon-driven, with real-world representations
- Have clear instructions
- Have something on the screen at all times
- Allow a child the ability to "escape" at any time
- Be open-ended
- Allow for independent exploration
- Have expanding complexity
- Allow for trial and error
- Include themes of interest to young children (animals, home life, school).

The numbers of software programs that appear to meet these criteria are limited. Despite the fact that the introduction to the High/Scope Survey of Early Childhood Software reports that "there's plenty of good software available," the average rating for the reviewed programs was 64 percent (Buckleitner, 1989). Haugland and Shade (1988) echo this concern. They write (p. 42): "There is an abundance of commercial software for young children on the market. Some of it contains attractive graphics and interesting

sound effects that are quite appealing. Yet, when carefully evaluated according to educational criteria, most software does not reflect a developmental approach to teaching and learning."

II. The Use of Microcomputers in Teaching Preschool Math and Science

In Section III of this document, there is a listing of 121 math and science software programs currently available for preschoolers. In the area of math, most programs concentrate on shape recognition and counting (Shade, 1989). Examples of programs that focus on shape recognition are *MacKids Shapes, Stickybears Shapes, Shapes & Patterns, Shape Games*, and *Shape & Color Rodeo. Stickybear Numbers, Charlie Brown's 1-2-3-'s, Conservation and Counting, The Counters*, and *Counting Critters* are examples of programs developed to teach number concepts. Science software centers more on specific topics, rather than functions. For example, *Exploring Your World: The Weather and All About You* looks at weather, *Mary Marvel...the Garden* examines planting, pollution, and growing flowers and vegetables, and *Talk About a Walk* focuses on the location of objects. In comparison to math software, science software is sparse in number (see Product Review).

Because of the preponderance of math software that concentrates on shape recognition and counting, it is not surprising that most of the research in the field focuses on these areas. Hungate (1982) and McCollister, et al. (1986) both found the computer to be effective in teaching numeral recognition and counting. The latter study found that "instruction by a teacher was more effective for children just beginning to recognize numerals but the opposite was true for more able learners." Clements (1988) interprets this as support for the use of computers as tools of practice. Brinkley and Watson (n.d.) found that three year olds could learn shape sorting tasks as effectively from a computer as from a doll task.

Recently attention has focused on the use of drawing programs to teach geometry and other spatial relationships. For example, boxing programs allow children to use "electric rubber band" and "area fill" functions to graphically show closure. Researchers in this area (Clements, 1989) feel that "the power of such drawing tools lies in the possibility that children will internalize the functions, thus constructing new mental tools."

Forman (1986) used drawing programs to make "kinesthetic prints" that children could move. He describes the potential of this medium in this way (p. 33):

> Teachers who expect computer drawing tools to help children draw more realistic pictures probably will be disappointed...On the other hand, teachers who see these media as new systems of cause and effect relations, logic relations, and spatial relations will make hundreds of interesting observations and will invent hundreds of games that children will find educational.

III. The Use of Microcomputers in Early Childhood Special Education

Special education has embraced microcomputer technology in great numbers (Ellis and Sabornie, 1986). As early as 1978, Chiang found that computer-assisted instruction was especially well-suited to the special needs of handicapped children for the systematic presentation of small increments of information, for immediate feedback, positive reinforcement, repetition, overlearning, and individualized instruction. A study by Mokros and Russell in 1986 reported that 88 percent of surveyed schools were using microcomputers with learning disabled or behaviorally disordered students.

In the area of early childhood, there has been a concomitant rapid growth in computer use (Rettig, 1987). Rettig reports growth in the number of projects serving this population, growth in software developed for this population, and growth in the number of descriptive articles describing this activity. However, in terms of concrete research, there is little representation in the literature (Semmel, et al., 1984).

Warren and Horn (1987) describe the situation thusly:

> The history of microcomputer applications in special education is so short that it is almost inappropriate to refer to it as history. It may be summarized by noting that first came some basic hardware (i.e., the Apple II), then some rather crude software, than a movement towards standards in software quality, then cheaper, more advanced hardware, then somewhat better software, and that brings us up to the present. Very little actual research on the efficacy of various microcomputer applications has yet been conducted.

Available literature, as has been pointed out already (Rettig, 1987; Warren and Horn, 1987), concentrates on descriptive overviews of ongoing projects, rather than delving into research-based studies. As with research on young children and microcomputers, most existing studies are fraught with shortcomings. Clements (1985) found a preponderance of exploratory studies, case studies, teacher-biased studies, and studies lacking control groups, random assignment, or concern for the Hawthorne effect. The extant literature can be grouped into three major areas of concern (Warren and Horn, 1987):

- systems applications
- instructional management applications
- direct instruction applications.

Systems applications, which include database management, word processing, recordkeeping, and spreadsheets are primarily used by teachers to monitor their special education children. The benefits to children are indirect: by decreasing paperwork, program efficiency and accountability may increase. The impact of the technology is on the program, not the learning process (Toole, Copel, and Fogarty, 1986). Instructional management applications are similar

to systems programs, except that the focus is on tracking individual students, conducting diagnostic assessments, and developing IEPs. These programs benefit students by providing greater flexibility in scheduling and decreasing management time for the teacher. However, again, the impact is on program components.

Whereas the use of microcomputers as management aids for early childhood special education appears to be well-received in the literature, its use as an instructional tool is somewhat less universally acclaimed. As Warren and Hann (1987, p. 78) comment, "The microcomputer is obviously developing into a useful tool for early childhood special educators, but by now most professionals have recovered from their initial illusions about microcomputer technology...They have clear value as a management tool, but their potential as a direct instructional aid in early childhood remains questionable."

Goin and Horn (1986) observe that most of the instructional software used in early childhood special education has not been specially designed for this audience, but is taken directly from commercially available software designed for young children in regular education programs. This in and of itself is not a negative practice. Watson, Chadwick, and Brinkley (1986) argue that, "current child development theory and most computer instruction which is developed for the norm group is also generally appropriate for the mildly handicapped. Where one makes allowances is in the instructional application, i.e. lower level and slower pace," (p. 203). Not surprisingly, then, the majority of the software being used with mildly handicapped populations concentrates on math skills such as counting and categorizing, other visual discrimination skills such as directional concepts and color, plus reading.

One of the few research studies to examine the impact of microcomputer-based instruction on preschool special education students was conducted by Fazio and Rieth (1986). Here, the authors examined the use of instructional preschool software during a free choice activity for mildly to moderately handicapped preschool children. They found that children enjoyed using the computer and maintained "high and extended levels of on task behavior" during computer use. However, it was not clear if students transferred learning to new situations. While this one study provides initial support for the instructional use of microcomputers with mildly handicapped children, it alone cannot provide definitive guidance. Without further documentation, there is little more than descriptive data on which to draw conclusions. Warren and Horn (1987) summarize the situation (p. 82):

> Early childhood special education, like other fields, is on the front end of a rapidly changing and expanding technology with great potential and many pitfalls. At present, we have more information about microcomputer technology than is really needed at some levels (i.e., the very basic introductory level) and very little information to guide our use and applications at the level of classroom integration.

IV. The Use of Videodiscs with Children

Interactive videodiscs, whether developed for business and industry or education, generally fall into three instructional models (Storey and Janszen, 1985):

- Tutorials--"how to" courses that help a user master a new subject or skill
- Visual database--archives of images in specific subject areas such as art
- Simulations--hypothetical explorations in which a user alters variables and makes other decisions that directly influence the outcome.

Although, according to Storey and Jantzen (1985), the specific benefits and limitations of these different instructional models have not been documented, "the literature does point out videodisc instructional strategies--common to all three models--which seem to be especially effective for enhancing motivation and learning" (p. 5). Chief among these strategies are the videodisc's ability to present high quality real-life images and to initiate active learning (Kearsley and Frost, 1985; Glenn and Greenberg, 1981).

Miller has this to say (1987, p. 1):

> Students [find] it easy to use the disc and they appreciate the high level of participation and control it [offers] them. It combines the dramatic qualities of television with the self-pacing available through books and educational software and they [credit] high quality visuals with contributing to the technology's appeal.

Char and Newman concur (1986, p. 25):

> ...videodisc technology can offer an exciting alternative to the information resources traditionally available to schools. The potential strengths lie in the presentation of superior, high quality visuals of real world phenomena, greater user control over the accessing and displaying of visual images, and the availability of interactive, problem-solving contexts for children's learning.

The preponderance of videodisc use in education has heretofore been in postsecondary settings, with varied results. Char and Newman write (1986, p. 18):

> A number of videodiscs in the market are little more than former instructional television programs or filmstrips placed on videodiscs, interspersed with occasional frames of text screens or review questions. In contrast, a handful of more innovative applications have been produced that make better use of the videodisc's random access capabilities and transfer the disc into databases and simulations...However, few such discs currently exist for the precollege student.

Of those discs that have been developed for use with precollege students, a sizable number have focused on science topics (Storey and Jantzen, 1985). This may be attributed to the natural affinity of videodisc technology to science. Storey and Jantzen write (1985, p. 9):

> The videodisc medium's unique strengths--interaction with and management of audio, visual, and textual information--and unique applications of instructional strategies, indicates that it may be ideally suited to the task of science education. By bringing the natural world into the classroom, videodiscs offer ways to teach and learn science facts, processes, methods that are active and participatory.

Studies by Storey and Jantzen (1985), Char and Talley (1986), and Miller (1987) all document successes in using videodisc to teach secondary school science. The Storey and Jantzen (1985) project retrofitted educational television programming from the PBS programs *NOVA* and *3-2-1 Contact* into an interactive videodisc that allowed students to practice process skills. Char and Talley (1986) examined how teachers and students in three New York City schools used videodisc. The authors concluded that (p. 30):

> the appeal and educational value of game scenarios and problem contexts created...was evident in all...classrooms. These materials clearly heightened students' motivation to learn with the disc, helped guide their visual focus and thinking concerning particular elements of the images and encouraged various kinds of problem solving.

The Miller (1987) study investigated the use in junior high school of a prototype interactive video, "Seeing the Unseen" which was designed to teach scientific inquiry skills. Miller reports (1987, p. 34):

> Results indicate that students, for the most part, found the videodisc system appealing and easy to use. As much of the literature has suggested, the videodisc's ability to provide realistic, high quality images was indeed viewed by students as a unique and positive capability of the technology, which contributed to a rich and enjoyable educational experience.

Miller also makes this comment about her findings (1987, p. 3):

> If the user does have control of the environment, there is an exhilarating sense of power that accrues to the experience. Learner control of the learning environment seems most important, perhaps instrumental, in improving the quality and quantity of the learning that takes place.

In the area of elementary and early childhood education, there is an exceedingly small body of literature on the use of videodisc with these age groups. Virtually all of the research in

this area has been done by Dr. J.A. Watson of the University of North Carolina.[1] Among research findings reported by Dr. Watson are the following (Watson, 1989):

- In a recently completed study of a science videodisc (on whales) developed for kindergartners, children's learning from the videodisc was compared in three settings: (1) a teacher who was present, but responded only to student questions; (2) a teacher who was present and did spontaneous teaching in response to the videodisc; and (3) a control situation in which a teacher taught the same material included on the disc using a text. Children in both experimental situations learned significantly more than the children in the control situation. However, there was no significant difference between the two experimental groups in learning gains.

- The optimum sequence length for a videodisc is no less than 10 minutes, no more than 20.

- Children are most attentive to the upper right hand quadrant of a screen, followed by the upper left. The lower left hand quadrant is the least effective quadrant for teaching children.

- Learning style is more important than grade level in making videodiscs appropriate for individual children. Most typical software is developed for children who are field independent, i.e., convergent thinkers. Ideally, children should be screened as to their learning style and then matched with a videodisc program that meets their needs.

- Children as young as three can be taught on a videodisc pre-math concepts such as right, left, up, down, above, and below.

This review of the literature and the interviews with experts (see Section II) were able to identify only two videodiscs for a preschool audience: Watson's disc on whales and a demonstration disc developed by Apple Computers in 1987. Research on the whale videodisc, as already noted, demonstrated significant gains in student learning. The Apple disc was designed for demonstration purposes only and research data are not available.

[1] Dr. Watson is one of the eight experts interviewed in Section II. The reader is referred to that section for more specific comments.

V. Teaching Math and Science Concepts in the Preschool

A. Mathematics

Mathematics programs currently available for young children are quite diverse in rationale, philosophy, and content (Johnson and Wilson, 1976). Programs based on a behaviorist viewpoint, such as Englemann and Carnine's Distar Program, use a system of rewards to provide motivation for learning. Behaviorist programs are directly opposite in approach to discovery-oriented programs that allow the child to control what is learned. Naturalist programs, such as those advocated by Neill (Gutek, 1968), advocate no formal introduction of mathematics; all learning is believed to be incidental.

Most attention in the literature is focused on cognitive developmentally-based approaches (Schickedenz, et al., 1977). These approaches are concerned with the way in which children develop cognitive structures and what factors influence this development. The developmentalist does not view the child as being under the control of selected stimuli (as the behaviorists do) but as free to choose whichever stimuli he or she desires (Johnson and Wilson, 1976). Central to developmental theory is the work of Jean Piaget. Piaget (1952) outlined several critical points in children's development where children's thinking becomes qualitatively different. These junctures correspond to these stages of development:

- Sensorimotor stage (0-2 years)
- Preoperational stage (2-7 years)
  - Preconceptual thought (2-4 years)
  - Intuitive thought (4-7 years)
- Operational stage (7-16 years)
  - Concrete operational thought (7-11 years)
  - Formal operational thought (11-16 years).

Piaget (1952) identified types of mathematical reasoning that can be expected of children at each stage. Moreover, according to Piaget, an understanding of conservation (which typically occurs at age 7) is prerequisite to understanding arithmetical operations. Mathematics for preschoolers, according to Piaget, then, involves learning pre-math concepts that will lay the foundation for later formal instruction. These concepts would include patterning, classification, seriation, numeration, counting, and spatial relationships.

Two programs popular in the field that are based on a Piagetian framework will be described here: The High/Scope *Cognitively Oriented Curriculum* (Hohmann, Banet, and Weikart, 1979) and *Mathematics Their Way* (Baratta-Lorton, 1976).

The High/Scope curriculum is not a mathematics curriculum per se, but rather a total

curriculum framework for teaching children in the preoperational stage of development. The authors describe their program philosophy this way (Hohmann, Banet, and Weikart, 1976, p. 3):

> For educators it should be stressed that logical-mathematical knowledge is the least "teachable" kind of knowledge there is. This knowledge is *inevitably* mastered by organically intact human beings, at least through the "concrete operations" level. Acceleration of development through didactic teaching does not seem to be a developmentally valid course since children construct their *own* models of reality, which develop over time in response to new experiences and exposure to other viewpoints.
>
> To us, the overriding implication of Piaget's work for educators is that *the teacher is a supporter of development*, and as such his or her prime goal is to promote *active learning* on the part of the child. Active learning--the direct and immediate experiencing of objects, people and events--is a necessary condition for cognitive restructuring and hence for development; put simply, young children learn concepts through self-initiated activity. Such activity, carried on in a social context in which an alert and sensitive teacher is a participant-observer, makes it possible for the child to be involved in experiences which produce the optimal degree of cognitive disequilibrium and hence the impetus for cognitive restructuring. The interests and talents of the child are most readily enlisted when learning is conceived as an interplay of physical and mental action initiated by the learner.
>
> Learning is decisive and lasting to the degree that it is active and direct, because active and direct experiences engage the senses and the motoric system; they provide the child with the core understandings around which new knowledge can be built through less direct means when the child is developmentally more mature.

Given their assumption that active learning is at the "heart" of the developmental process, the High/Scope curriculum provides teachers with 50 key experiences that teachers can use in planning and evaluating learning experiences. Using a "Plan-Do-Review" process in which teachers work individually with children to plan their learning experiences, children are introduced to key experiences that help them develop spatial, temporal, and logical thinking. Key experiences directly related to mathematical learning include classification, seriation, number, and spatial relationships.

Mathematics Their Way is an activities book designed to help children develop an understanding of the relationships and interconnections in mathematics. Like the High/Scope curriculum, it focuses on the preoperational child who needs direct experience with math concepts, not abstractions. The author puts it this way (Barratta-Lorton, 1977, p. xiv):

> A page of abstract symbols, no matter how carefully designed or simplified, *because of its very nature*, cannot involve the child's senses the way real materials can. Symbols are not *the concept*, they are only a representation of the concept, and as such are abstractions describing something which is not visible to the child. Real materials, on the other hand, can be manipulated to illustrate the concept concretely, and can be experienced visually by the child.
>
> A variety of familiar materials gathered from the child's world enable a teacher to begin where the child is, in *his or her* world, and with them, to gradually build a bridge to the adult world of abstraction. Because the materials are real, and physically present before the child, they engage the child's senses, and are, *in themselves*, enjoyable and rewarding. The materials provide motivation for learning at the same time that they provide the tools for exploration and problem solving.
>
> During the beginning stages of concept development, abstract symbolization tends to interfere rather than enhance the understanding of a concept. For this reason, a great deal of this book deals with ideas that develop concepts without the use of any written numerals. Abstract symbolization is only used to label a concept which the child *already grasps*, never as a "material" from which the child is taught a concept. The emphasis throughout this book is making *concepts*, rather than numerical symbols, meaningful.

For children who have not yet learned to conserve, *Mathematics Their Way* focuses on free exploration, patterning, sorting and classifying and counting.

B. Science

Whereas the early childhood field is cluttered with theories related to the teaching of mathematics, theory on science education is conspicuously absent. Dietz and Sunal have this to say on the subject (1977, p. 125):

> The early childhood educator encounters a virgin field in developing new theory with respect to science learning. The past fifteen years has included the beginning of the development of curricula in the area of science education.

Much of what passes for science education in early childhood programs are incidental experiences--baking bread, planting a garden, making note of seasons. Those programs that do include an emphasis on science, as with math, tend to be those based on a Piagetian framework. As Schickedanz and Stewart observe (1977, p. 210):

> Pioneers in early childhood science saw science as a discipline beyond the ken of young children. Today, science is considered one of the principal areas of the curriculum at the preprimary and primary levels. Partly as a result of Piaget's work in the development of notions of causality and logical thinking, we are now aware of ways in which children gain and organize information. We also know that they not only enjoy contact with science study, but that they benefit from guided experiences which involve processes such as observing, experimenting, classifying, and hypothesizing.

Using this framework, programs such as High/Scope's *Cognitively Oriented Preschool Curriculum* could be used to teach children pre-science, as well as pre-math concepts. Key concepts such as classification, spatial relationships, and time could be used for science. Learning about liquid volume, the rotation of objects, and problem solving lend themselves to teaching children both math and science concepts simultaneously (Riechard, 1973).

VI. Adapting Preschool Math and Science for Special Education

Although it is generally acknowledged that all children are more alike than different, the field of early childhood special education has emerged in an effort to identify and "conscientiously consider" the unique differences of special needs children and to select content, techniques, and practices which will meet these unique needs (Cook, Tessier, and Armbruster, 1987). Hohmann, Banet, and Weikart (1977) have identified two basic approaches to the design of individualized educational programs for young handicapped children: diagnostic/corrective interventions and the developmental approach.

Diagnostic/corrective interventions are philosophically rooted in the behaviorist approach described earlier. Based on the results of testing, specific objectives are targeted for remediation. Behavior modification and incentives are sometimes used to motivate children to attain their objectives. Teaching of set skills is done in clinical sessions, where the child is taught to master the prescribed skills.

The developmental approach, as might be expected, takes a very different approach. Rather than testing for deficits, this approach observes where a child is developmentally and then provides the child with experiences that will challenge the child to the next developmental level. Instead of a teacher initiating the activities, the developmental approach allows the child to have an active role in planning his or her learning program.

The developmental approach, quite naturally, is supported by those who support a Piagetian framework for instruction. Cook, Tessier, and Armbruster (1987) note that considerable support for this viewpoint may be found in the literature. Gallagher and Reid (1981), for example, found that children with developmental delays appear to progress through the same

stages of cognitive development as do nonhandicapped children. However, the authors caution, the rate of progress and ultimate level of development is influenced by the severity and nature of each child's handicap.

In structuring programs for children who are mildly cognitively impaired, cognitive developmentalists would therefore, recommend using a program such as High/Scope's *Cognitively Oriented Curriculum* or Barratta-Lorton's *Mathematics Their Way* which allows children to progress at their own rates and in their own ways. Hohmann, Banet, and Weikart (1977) describe their success in using their curriculum with special needs children in this vignette (p. 17):

> We begin a cycle of experiences with concrete materials and physical involvement-both sensory and motoric-on the part of children. For very young children or for children who are still functioning primarily at the sensorimotor level, we may stay at this concrete level. For those who are able to use more abstract mental abilities, we extend the active, concrete experience via representations in a variety of modes and, of course, through language. We try, always, to tie representational activity to some concrete event or experience, even when children are able to deal with the concept or event on a more symbolic level. Representational activity may be channeled by the teacher, but the specific content and style of the representation is not dictated by the adult.
>
> We have found the key experiences and the general strategy of building on active learning with real materials to be highly effective with special-needs children. Some special-needs children are still functioning at the sensorimotor level when they are three years old or older. For these children, as well as for others with less severe delays, the basic manipulative/exploratory activities are the developmentally appropriate ones; there is no attempt immediately to extend these activities into ones that require high-level (i.e., more abstract) symbolic or representational processes. Thus, for an educable or trainable retarded preschool child, we provide readily transformable materials such as water, sand and finger paint. Of course, these materials are used by all preschool children, but the activities the special-needs child engages in with the materials may be different, and the teacher's responses and questions are based on the way the child interacts with the materials. A good learning environment encourages children to interact with materials in diverse ways, according to their developmental level.
>
> *EXAMPLE: A normally developing four-year-old child will use sand to make "roads" for toy cars. A child still functioning at the sensorimotor level will be interested in filling and emptying containers of sand, but not in using the sand to stand for something else.*
>
> *EXAMPLE: A four- or five-year-old can make playdough from a picture-recipe chart, measuring the flour, water, salt and oil with measuring cups and spoons. A child who is developmentally two years old, however, will enjoy exploring the*

> *gooey product of the older child's labors, but won't be able to participate except by observation in decoding the chart, counting the scoops, etc.*

The developmentally oriented approach used by Piagetian-based curricula has received general acceptance in the recent literature by early childhood special educators. Cook, Tessier, and Armbruster write (1987, p. 253):

> Whatever the theoretical orientation of and the skills expected by kindergarten teachers, nearly every preschool curriculum has similar preacademic (or cognitive) goals. In one way or another activities are included related to classification (grouping) including sorting and matching, categorization, and seriation (ordering), and the development of concepts related to color, shape, space, time, number, opposites, and letters. In general, expectations move from the concrete to the abstract, from the simple to the complex, and from the here and now to the remote in time and space.

To help children who are mildly cognitively impaired in developing these concepts, Cook, Tessier, and Armbruster (1987) offer these suggestions:

- Present children with three-dimensional, concrete tasks--not abstract ones.
- Find the child's most efficient mode of learning and use it. If it is visual, use visual cues to assist auditory directions. If it is motoric, use movement in teaching skills.
- Pace the learning experience. Many special needs children must work extra hard to concentrate. They may need rest times and quiet activities. Children who process information more slowly should receive less information or receive it over a longer time.
- Provide repetition and intermittent practice
- Model appropriate behaviors
- Break down tasks into simple, short steps, moving from the easiest to the most difficult
- Provide directions slowly and in small steps.

Rowbury (1982) has a complementary list of suggestions for adapting curricula to meet the needs of mildly handicapped preschoolers:

1. *Location for learning.* A constant assigned location will reduce distraction and will help to cue attentiveness and task orientation.
2. *Selection of materials.* Materials most appropriate for "delayed learners"

include those that:

a) are "concrete" representations of the concept being taught.
b) provide a maximum of tactile and visual information with little verbal interpretation.
c) incorporate frequent but easily performed manipulative responses from the child.
d) easily isolate the concept being taught.
e) can be arranged in steps and presented to the child as specific, visible products to be completed.

3. *Visual arrangement of materials.* The following suggestions will be helpful to the child who has difficulty organizing his or her own work area. Such a problem is common to children who have delays in perceptual development.
   a) Limit materials to only those needed to complete the task.
   b) Arrange initially needed materials before the child arrives or ask the child to bring the red tub (which contains necessary materials) to the center. This prevents distractible children from having to wait and possibly beginning to lose interest.
   c) Be certain that all materials are within the child's reach and at eye level.
   d) Put loose materials in a container to avoid spills and their resulting distraction.
   e) Use visual supports and guidelines such as the placement card holders that come with some visual matching cards to help the child develop necessary organization skills like left-right progression.

VII. Conclusions

From the disparate topics researched for this literature review, the following conclusions can be made:

1. Hard effectiveness data on learning by young children through computers is sparse. Moreover, the inappropriateness of designs employed by many studies and the lack of longitudinal data have been cited as ongoing research problems. Most research data concentrate on social behaviors and effective ways to use computers. Studies have indicated that young children are motivated to use computers, that children learn best when the teacher serves as a "facilitator," that computers do not isolate users, and that young children can readily master hardware and software.

2. Most research on young children and computers points to the "potential" of computers to teach. As Clements (p. 42, 1987) summarized in his review of research literature, "Young children do not need computers any more than they 'need' any of the many potentially valuable learning centers. There is, however, nothing to lose and potentially rich benefits to acquire through informed use of computers."

3. There are currently over 350 software programs available for preschool children; 121 of these are in the areas of math and science, with the majority of these focusing on counting and shape recognition. The developmental appropriateness of commercial software in general has been strongly questioned in the literature.

4. While there is a dearth of research in the use of computers in early childhood special education programs, experts have singled out the management and instructional potential of software as a benefit for early childhood special education programs.

5. Videodiscs have been successfully used in postsecondary and secondary education environments to teach science and other subjects. The only known research study involving preschoolers (i.e., kindergarten students) found that experimental classes in which teachers used a videodisc to teach children about whales yielded significantly higher learning scores than the control classrooms in which teachers taught from a text.

6. Preschool math is taught from a variety of theoretical frameworks. Most support in the literature is for a Piagetian-based approach in which children are taught pre-conservation skills such as patterning, classification, seriation, and numeration. (The High/Scope *Cognitively Oriented Curriculum* and *Mathematics Their Way* were highlighted as examples of curricula using a Piagetian framework.)

7. Science education is a more recent addition to the preschool curriculum. Those programs that use an integrated approach primarily focus on Piagetian concepts such as spatial relations, classification, and time.

8. Research in early childhood special education supports the use of a developmental approach to instruction which is Piagetian-based. Delayed learners are encouraged to progress at their own pace.

9. Early childhood special education programs focus on the same cognitive goals as regular preschool programs: classification, sorting and matching, categorization, seriation, color, shape, space, time, opposites, and letters.

10. Accommodations for teaching mildly cognitively impaired learners the Piagetian-based concepts listed above have been put forth by special educators such as Cook, Tessier, and Armbruster (1987) and Rowbury (1982).

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Section II

Expert Interviews

SECTION II: EXPERT INTERVIEWS

The panel of experts interviewed for this study, together and individually, represent a broad spectrum of backgrounds and knowledge in the key areas of concern. The matrix, which appears as below, displays this information in graphic terms. As may be seen, all are experts in early childhood education. Three-quarters of the experts have backgrounds in computer technology and three-quarters in math and science. Six of the eight experts (Buckleitner, Davidson, Haugland, Shade, Watson, and Wolfinger) are likewise currently involved in research regarding young children and technology. Dr. Watson, the only known person to be currently developing and researching videodisc technology for preschoolers, is included in the panel. The governmental policy perspective is represented by Drs. Morissey and Hebbeler.

The individual comments of the experts have been recorded on questionnaires appended to this chapter. For ease of presentation, the comments of the group as a whole will be summarized here, question by question. In reviewing responses, it should be noted that not all interviewees responded to all questions. If an individual felt that the question being asked was not in his or her field of expertise, no response was recorded.

EXPERT INTERVIEWED	EARLY CHILDHOOD EDUCATION	SPECIAL EDUCATION	COMPUTER SOFTWARE TECHNOLOGY	VIDEODISC TECHNOLOGY	MATH AND SCIENCE EDUCATION	RESEARCH/UNIVERSITY AFFILIATION	CLASSROOM TEACHER/PRACTITIONER	GOVERNMENT/POLICY
Buckleitner	●		●		●	●	●	
Davidson	●	●	●		●	●	●	
Haugland	●	●	●		●	●		
Hebbeler	●	●	●		●			●
Morissey	●	●						●
Shade	●		●			●		
Watson	●	●	●	●	●	●		
Wolfinger	●				●	●	●	

Background Areas Represented by Panel Experts

A. DESIGN AND APPROACH

1. *How applicable do you think research on software for preschoolers is to the use of videodiscs with 3 to 5 year olds?*

Of the seven experts who answered this question, all thought research on software was applicable to videodisc technology. Responses ranged from being entirely applicable to "about 60 percent" applicable. Most cited the research on the interactive nature of software as most relevant to our purposes. One respondent countered, though, that most of the research has been short–term; relatively little research has been done over time.

2. *How long do you think we can expect mildly cognitively impaired 3 to 5 year olds to sit at a computer using a videodisc?*

Seven experts responded to this question. Four respondents cautioned that the individuality of children made generalizations difficult, especially in terms of their personalities and learning styles. The nature of the program and the adequacy of preparation were also cited by several experts as having a bearing. Still, 5 of the 7 experts felt that 10 minutes was probably an appropriate figure to work with. The research with videodiscs found 10 minute segments to be appropriate for both handicapped and nonhandicapped children. Older and computer-experienced children could be expected to sit for much longer periods (e.g., 30 minutes).

2a. *Would there be any appreciable difference in the time that nonhandicapped children could spend at a computer?*

Of the six individuals responding to this question, all felt there would be no difference between handicapped and nonhandicapped children.

3. *What can be done to maximize the children's interest in using the videodisc?*

The seven panelists who responded to this question provided a variety of strategies, although one person thought the medium to be so inherently motivating that motivation was not a problem. Four of the experts gave suggestions rooted in the need to give the child control over the program. Almost all noted the need to keep the program interactive at all times. Other suggestions included:

- Let the child know that he or she can leave the program at any time by keeping the escape icon in permanent view;
- Make graphics realistic;
- Use bright, flashy action;
- Never let a screen fade out completely;
- Prepare the child in advance.

3a. *Are you aware of any research on the use of videodiscs as a motivational tool for young children?*

Only two individuals answered this question, although several respondents cited Watson's work at North Carolina. Responses received were:

- Children are easily distracted; don't make them wait.
- Never let a screen fade out completely.
- Use smooth transitions.
- Two screen systems may be satisfactory for young children.

4. *What suggestions would you make in terms of graphics? For example, should there be more video and less computer graphics? What about use of animation? Does it help or is it distracting? What about use of written words as labels, etc.?*

Seven panelists provided responses. Their answers can be summarized as follows:

Use of computer graphics vs. video: All who commented thought there should be a blend of both, although there was some discrepancy as to what proportion this blend should be. Two individuals thought the strength of the videodisc is in its ability to portray reality, and leaned toward a higher use of video. Three experts, however, thought that because the interactive elements occur through computer graphics, computer graphics should be the driving force.

Animation: All who answered (seven) thought animation was both appropriate and important. Some cautions were raised, though, that it not be so flashy as to obscure content or become entertainment.

Use of written labels: Two respondents felt written labels are very helpful and should definitely be used, while another respondent felt the use of labels would be a definite mistake. The other four respondents thought labels should probably be

used, although they doubted they would be helpful. However, none of these four thought labeling would be distracting to our audience.

5. *Should all learners be presented with a variety of strategies or should one strategy be primary and alternative strategies be presented only to those who don't get the first way?*

Six individuals responded to this question. In general, answers broke out according to expertise. Those with a heavy technology orientation felt that children should be allowed to continue as far as they can without stopping. As one expert put it, "Three to five year olds would be confused rather than enlightened by seeing numerous ways of looking at the same thing." Those with a lesser familiarity with technology felt that all learners should get a variety of approaches. Two of the respondents also referenced the effects of learning styles on a child's ability to master a program.

6. *Should there be a recordkeeping system? If so, what information, other than number of attempts, should be provided?*

Two of the eight respondents felt that there should be no recordkeeping system. The six panelists who were in favor of a recordkeeping system offered these suggestions:

- as a management/diagnostic tool for the teacher
- to record time spent on specific tasks
- to keep track of types of errors and successes made
- to demonstrate a learning curve.

7. *What should be the teacher's role?*

There was consensus among all eight respondents to this question: The teacher should be a facilitator and a diagnostician. "Enlightened guidance" is the term used by one respondent to describe this role. One respondent also noted that the teacher's role should also include contributing to the development of the final product.

8. *What techniques/strategies are you familiar with that you think would enhance this effort?*

The seven respondents to this question provided a number of individual recommendations. Among the techniques/strategies offered were these:

- actively involve the children in the learning process

- use a mouse; joysticks are too big for children this age
- avoid transitions
- allow children to work with other children
- integrate the computer into normal classroom activities
- make the computer a supplement to hands-on experiences taking place in the rest of the classroom
- make children aware of what they're doing and why
- train children before they use the program
- centrally locate the machine
- use age-appropriate vocabulary.

B. CONTENT

1. *Do you think the proposed videodisc should be used for introducing content, as a reinforcer of content already learned, or for a combination of both?*

Of the seven respondents to this question, two commented that the videodisc could be used in any way and that the choice should be ours. Four respondents felt that the best use of the videodisc was to both introduce and reinforce content. One respondent strongly felt that the videodisc should only be used to reinforce content, following hands-on experiences in the classroom.

2. *Do you have any suggestions for integrating the videodisc into ongoing preschool programs?*

All seven of the respondents to this question had specific suggestions. Their comments included these:

- Keep the presentation as interactive as possible.
- Tie into items of everyday life such as animals and transportation.
- Make the tasks child-initiated.
- Integrate into ongoing classroom activities.
- Emphasize everyday skills the child needs.
- Allow the child to interrupt the video and to access visual databases.

3. *Do you think we can use the same concepts as foundations for both math and science, or do you feel there should be a delineation between the two?*

Six of the seven respondents to this question felt content should be integrated. As one respondent noted, "It would be almost absurd to pull them apart. Children don't think in sections." The one respondent who originally thought there should be a delineation, asked the interviewer for her opinion. Upon being told that it was our thought to combine the two (subject to the results of these interviews) and hearing our rationale, the respondent changed her opinion to concur, commenting, "The integrative approach is stronger as well as innovative."

4. *How many concepts is it feasible to include? Would you suggest fewer concepts in more depth or multiple concepts at an introductory level?*

This question, upon reflection, was not very strong, given that the technology itself will delimit the number of concepts. However, the five panelists who chose to respond to this question all stated their preference for including fewer, well-developed concepts.

5. *Here are some topics we've been considering focusing on in the videodisc:*

CLASSIFICATION	[including observing attributes, sorting, and comparing and contrasting]
SERIALIZATION	[arranging things according to properties such as height, weight, and temperature]
NUMBER	[one-to-one correspondence, counting]
TIME	[units of time, sequencing of time]

How do you react to these? Do you agree with this approach, or would you go another route? What other topics would you feel it's important to include as foundations for math and science?

All eight of the panelists responded favorably to these choices. Three panelists expressed their support for our reliance on a Piagetian framework. One panelist suggested beginning with classification since this is easiest for teachers. The math and science educator suggested other related topics, including patterning, observation, graphing, measuring with body parts, and beginning cause-and-effect relationships.

C. ADDITIONAL THOUGHTS AND RECOMMENDATIONS

Seven of the eight panelists offered final suggestions. In many instances, their comments summarized opinions touched on earlier in their interviews. Among the comments received were:

- The videodisc should not supplant classroom toys and manipulatives.
- The videodisc should coordinate with everything that occurs in the classroom.
- Child control is key to development.
- Pilot testing should be done early on.

Several of those interviewed concluded that the videodisc is just beginning to reach its potential and that our project can serve a great need. Two panelists did, however, feel obliged to comment that because the hardware is so expensive, its use in the classroom will be limited. Still, one of the respondents noted, "Why not reach for the stars."

SUMMARY

In general, there was a great deal of consensus among those interviewed concerning both design and content considerations. These conclusions can be drawn from the interview data:

- Research on computer software and young children is felt to be applicable to videodiscs. In particular, child control and ongoing interaction have been singled out as crucial for success.

- The target audience can be expected to sit at a computer screen for approximately 10 minutes at a time. Individual differences, particularly learning style, will impact on attention.

- Interest in the videodisc can be maximized by making the program highly interactive and giving the child control.

- There should be a balance between computer graphics and video portions. Since interaction is rooted in the computer graphics segments, technology experts feel that the balance should be tilted toward computer graphics.

- Animation is recommended.
- Written labels are recommended, although their benefits are questioned by several experts.
- Technology experts feel that children should be allowed to progress through a program to as high a level as possible without stopping. Those without a technology background recommend presenting all children with alternative learning strategies.
- Recordkeeping is favored by the majority of experts, especially as a management tool for the teacher. Attention and learning curve data are felt important to keep track of.
- The teacher should serve as a facilitator and diagnostician; he or she should allow the child to interact with the machine on his or her own.
- Math and science concepts should be integrated in the videodisc.
- A Piagetian approach to content should be used. Concepts such as patterning, classification, and serialization — which are applicable to both pre-math and pre-science — are endorsed.

Section III

Product Review - Currently Available Math and Science Software for Preschoolers

CRITERIA FOR SELECTION

The principal sources of information on the products included in the listing of Currently Existing Computer-based Instruction in Preschool Math and Science are:

The Educational Software Selector (TESS) published by EPIE Institute, both the 1986-1987 Edition and the 1988 Supplement

Survey of Early Childhood Software published by The High/Scope Press (1989).

The following limitations were placed on the software included in this list:

The beginning age for which the software is considered appropriate is no older than 4; the ending age, no older than 7.

Nothing is included which was published prior to 1982.

Programs written for early microcomputers with very low memory (32K or less) or for computers no longer on the market have not been included.

No programs are included which are available only on tape or cartridge.

Since the focus of the proposed program is on math and science concept development:

The listing does not include programs which have number recognition components when the primary emphasis is on reading readiness, rather than the development of math concepts.

The listing does not include programs which are primarily memory games (concentration format) even when shapes or numbers are used as the memory objects.

KEY TO LISTING OF
CURRENTLY EXISTING COMPUTER-BASED INSTRUCTION
PRESCHOOL MATH AND SCIENCE

Software type comes from TESS whenever the software is listed there. General types include skills practice, drill, and simulation. Since almost all of this software has a game component, no specific descriptor "game" is used.

Numbers often appear in parentheses following a topic (e.g. Number - Yes (3,4,8)). These are the specific concepts covered in the software as listed in the High Scope publication. A key for interpreting these follows on the next page.

Ratings which appear are primarily the ratings from the High Scope (HS) or EPIE publications. However, when neither of these is available, but another review source is cited in TESS, that rating is given.

CURRENTLY EXISTING COMPUTER-BASED INSTRUCTION
PRESCHOOL MATH AND SCIENCE

Title - **Adventures in Space**
Publisher - Scandura Training Systems
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - Yes
Time - No
Description - 10 activities in spatial concepts (e.g. up-down, in-out, and above-below).
Recordkeeping available - No
Ratings - HS-46

Title - **Adventures of Dobot**
Publisher - Educational Activities, Inc.
Hardware Requirements - IBM, Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - No
Classification - No
Seriation - Yes
Spatial Relations - Yes
Time - No
Description - Seven games in which child uses arrow keys to move robot to sort letters, arrange rods according to length, and match numerals.
Recordkeeping available - Yes
Ratings - HS-70

Title - **Adventures of Jimmy Jumper**
Publisher - ECS
Hardware Requirements - Apple II line
Additional Hardware - Echo speech synthesizer; game paddle optional
Software Type - Skills practice
Audience - Normal children
Age - 2.5 - 5

Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - Yes
Time - No
Description - 12 screen story program. Story is voiced while graphics show prepositional concepts and students advance story using game paddle or space bar.
Recordkeeping available - No
Ratings - HS-69

Title - **Alphabet Song and Count**
Publisher - Edusoft
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - Yes
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - Counting, addition and subtraction
Recordkeeping available - No
Ratings - HS-81

Title - **Animal Photo Fun**
Publisher - DLM
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - ? (Probably skills practice, maybe tutorial)
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - No
Classification - Yes
Seriation - No
Spatial Relations - No
Time - No
Description - 6 games in which children match animals with their habitats.
Recordkeeping available - No
Ratings - HS-70

Title - **Astro-Grover**
Publisher - Hi-Tech Expressions

Hardware Requirements - Apple II line, IBM, Commodore 64
Additional Hardware - Keyboard overlay included; Apple version compatible with Muppet Learning Keys.
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 5 games that provide practice counting, adding and subtracting objects in an outer space context. "Lively graphics and sounds not related to content."
Recordkeeping available - No
Ratings - HS-41

Title - **Beginning Counting**
Publisher - MicroEd, Inc.
Hardware Requirements - Amiga
Additional Hardware - Mouse; voice synthesizer
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - Children count objects, identify the names of numbers and arrange numbers in order. Spoken feedback and recitation of number names. 2 disks and several difficulty levels.
Recordkeeping available - No
Ratings - HS-43

Title - **Boars Tell Time**
Publisher - Random House Software
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - Yes (4)
Classification - No
Seriation - No
Spatial Relations - No

Time - Yes(9)
Description - 3 activities provide opportunities to tell time and relate analog to digital format.
Recordkeeping available - No
Ratings - HS-69

Title - **Body Awareness**
Publisher - Mindscape, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - Yes
Time - No
Description - 3 games provide practice with body part locations, names of body parts and seasonal clothing
Recordkeeping available - Yes (and teacher modification capability)
Ratings - HS-64

Title - **Charlie Brown's 1-2-3-'s**
Publisher - Random House Software
Hardware Requirements - Apple II line
Additional Hardware - Echo speech synthesizer
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - Yes (3,4,8)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - Child selects numeral and uses spacebar of number keys to count out the number.
Recordkeeping available - No
Ratings - HS-67

Title - **Children's Carousel**
Publisher - Dynacomp, Inc.
Hardware Requirements - Apple II line, Atari
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7

Topics Covered -
Number - Yes
Classification - Yes
Seriation - No
Spatial Relations - No
Time - No
Description - 8 games, some of which provide opportunities for practicing skills related to number and classification.
Recordkeeping available - No
Ratings - None

Title - **Children's Learning Center**
Publisher - Mind Mate Software
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Drill
Audience - Normal children and visually impaired children
Age - 4 - 7
Topics Covered -
Number - Yes
Classification - Yes
Seriation - No
Spatial Relations - Yes
Time - No
Description - 11 programs (plus 5 modified for the visually impaired) provide practice in number recognition, color and shape recognition, counting, and placement and relative placement.
Recordkeeping available - Yes
Ratings - None

Title - **Child's Play**
Publisher - Dynacorp, Inc.
Hardware Requirements - Apple II line
Additional Hardware - Joystick or game paddle
Software Type - Skills practice, drill
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - Activities for practice in recognizing shapes, relative size, and counting.
Recordkeeping available - No
Ratings - None

Title - **City-County Opposites**
Publisher - Random House Software
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice, drill
Audience - Normal children
Age - 3 - 7
Topics Covered -
    Number - No
    Classification - No
    Seriation - Yes(1)
    Spatial Relations - No
    Time - Yes(1)
Description - Presents and illustrates 20 antonym pairs.
    Child uses left right arrows to alternate between pictures
    illustrating antonyms.
Recordkeeping available - No
Ratings - HS-78

Title - **Classification**
Publisher - Aquarius People Materials
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice, tutorial
Audience - Normal children
Age - 4 - 7
Topics Covered -
    Number - No
    Classification - Yes
    Seriation - No
    Spatial Relations - No
    Time - No
Description - A 5 disk series which includes activities for
    classification by setting, by physical attributes,
    and by function, and matching activities.
Recordkeeping available - No
Ratings - None

Title - **Color Find**
Publisher - ECS
Hardware Requirements - Apple II line
Additional Hardware - Echo speech synthesizer optional
Software Type - Skills practice
Audience - Normal children
Age - 2.5 - 5
Topics Covered -
    Number - No
    Classification - Yes(2)
    Seriation - No

Spatial Relations - No
Time - No
Description - One of 9 colors fills the screen; child presses correspondingly colored sticker on keyboard. Speech synthesizer optional to say "press a color."
Recordkeeping available - Yes (and teacher modification capability)
Ratings - HS-69

Title - **Colors and Shapes**
Publisher - Hartley Courseware, Inc.
Hardware Requirements - Apple II line
Additional Hardware - No
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - No
Classification - Yes(1)
Seriation - Yes(1)
Spatial Relations - No
Time - No
Description - 4 activities based on matching shapes and colors. Child selects speed, sound, and difficulty level.
Recordkeeping available - No
Ratings - HS-76

Title - **Come Play With Pockets**
Publisher - World Book, Inc.
Hardware Requirements - IBM
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 5
Topics Covered -
Number - No
Classification - Yes(1)
Seriation - No
Spatial Relations - Yes(1)
Time - No
Description - 6 games in which a child moves blocks, remembers a sequence, plays Simon Says, or finds a bucket that a ball landed in.
Recordkeeping available - No
Ratings - HS-66

Title - **Concept Formation: Shape Matching**
Publisher - The Conover Company Ltd.
Hardware Requirements - Apple II line
Additional Hardware - None

Software Type - Skills practice
Audience - Normal preschool children and developmentally disabled older students
Age - 4 - 5
Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - Yes
Time - No
Description - Activities in recognizing 6 basic shapes.
Recordkeeping available - Yes
Ratings - None

Title - **Conservation and Counting**
Publisher - Hartley Courseware, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(1,2,3,4)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 4 games in which child matches sets of objects or matches numbers with sets and estimates quantities, all with numbers less than 10. Picture menu gives child control.
Recordkeeping available - ?, but limited teacher options available.
Ratings - HS-71

Title - **The Counters**
Publisher - Sunburst Communications, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(2,3,4)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 3 counting, addition and subtractions activities with numbers less than 10. Adult help required.

Recordkeeping available - No
Ratings - HS-69

Title - **Counting**
Publisher - MECC
Hardware Requirements - Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - Yes(3,4,7)
Classification - Yes(1)
Seriation - No
Spatial Relations - No
Time - No
Description - 6 math games for rote counting, counting objects in a set, addition problems with sums less than 10, and additional problems with sums greater than 10.
Recordkeeping available - No
Ratings - HS-60

Title - **Counting and Ordering**
Publisher - Micro Power & Light Company
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 6
Topics Covered -
Number - Yes(3,6)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 2 games to practice counting.
Recordkeeping available - No
Ratings - HS-56

Title - **Counting Critters**
Publisher - Mindscape, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - Yes(3,4,7)
Classification - No

Seriation - No
Spatial Relations - No
Time - No

Description - 3 activities for counting, adding and subtracting with sums up to 12.

Recordkeeping available - Yes

Ratings - HS-62

Title - **Counting Critters 1.0**

Publisher - MECC

Hardware Requirements - Apple II line

Additional Hardware - None

Software Type - Skills practice

Audience - Normal children

Age - 3 - 6

Topics Covered -

Number - Yes(3,4,7,8)
Classification - Yes(2)
Seriation - No
Spatial Relations - No
Time - No

Description - Five games in which child matches numerals from 1-20, matches sets with numbers, creates sets corresponding to numbers and uses numerical order to fill in a dot to dot design.

Recordkeeping available - ? - but limited teacher options available.

Ratings - HS-81

Title -**Counting Skills**

Publisher - Aquarius People Materials

Hardware Requirements - Apple II line

Additional Hardware - None

Software Type - Skills practice

Audience - Normal Children

Age - 3 - 6

Topics Covered -

Number - Yes(2,3,4)
Classification - No
Seriation - No
Spatial Relations - No
Time - No

Description - 9 disks covering a range of counting skills. Little interaction or child control.

Recordkeeping available - No

Ratings - HS-40

Title - **Critter Count**

Publisher - Aquarius People Materials

Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(9)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - Addition and subtraction problems presented in 2 formats - with numerals and graphically represented. Rigid pacing; child has little control.
Recordkeeping available - No
Ratings - HS-34

Title - **Dinosaurs**
Publisher - Advanced Ideas, Inc.
Hardware Requirements - Apple II line, IBM, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 2.5 - 5
Topics Covered -
Number - No
Classification - Yes(1,2)
Seriation - No
Spatial Relations - No
Time - No
Description - 5 games about 6 dinosaur breeds including: matching an outline to its twin, classifying dinosaurs by what they ate, where they lived, and recognizing their written names. Uses pictures menus and includes stickers and coloring book.
Recordkeeping available - No
Ratings - HS-65; EPIE-Highly recommended

Title - **Early and Advanced Switch games**
Publisher - R.J. Cooper & Associates
Hardware Requirements - Apple II line
Additional Hardware - Echo speech synthesizer optional
Software Type - Skills practice
Audience - Children with motor impairments
Age - 2 - up
Topics Covered -
Number - No
Classification - Yes(2,4)
Seriation - No
Spatial Relations - Yes (4,8)
Time - Yes (1)

Description - 13 games using only a single switch or key to make noises or visual effects, build a scene, play music, build shapes, count, match shapes and colors, move through a maze, or construct a face.
Recordkeeping available - No
Ratings - HS-75

Title - **Early Childhood Learning Program**
Publisher - Educational Activities, Inc.
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - None
Software Type - Tutorial
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - Yes(1)
Time - Yes(3)
Description - Openended context for exploration in directionality, planning, sequencing, etc, based on LOGO concepts.
Recordkeeping available - No
Ratings - HS-53; EPIE-Do not consider

Title - **Early Elementary I**
Publisher - Compu-Tations
Hardware Requirements - Apple II line, IBM
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - Yes(4)
Classification - Yes(1)
Seriation - No
Spatial Relations - No
Time - No
Description - 4 activities in counting shapes, matching colors, number recognition, and matching shapes.
Recordkeeping available - Yes
Ratings - HS-27

Title - **Early Games**
Publisher - Springboard Publications
Hardware Requirements - Apple II line, IBM, Commodore 64, Atari
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children

Age - 3 - 6
Topics Covered -
Number - Yes(3,8)
Classification - Yes(1)
Seriation - No
Spatial Relations - No
Time - No
Description - 9 games to provide practice in a wide variety of areas.including matching numbers, counting, addition and subtraction with sets, and matching shapes.
Recordkeeping available - No
Ratings - HS-60; EPIE-Recommended with reservations

Title - **Early Learning Friends**
Publisher - Spinnaker Software Corp.
Hardware Requirements - Commodore 64
Additional Hardware - Joystick
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - No
Classification - Yes(1,2,5)
Seriation - No
Spatial Relations - No
Time - Yes(1,3)
Description - 3 games, including a maze game in which the child moves a character through a cave, avoiding "Wufflegumps"; shape shop, in which child makes a toy's missing part, considering the color and shape needed.
Recordkeeping available - No
Ratings - HS-71

Title - **Early Math**
Publisher - MicroEd, Inc.
Hardware Requirements - Amiga
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(3)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 4 activities in ccunting, number sequencing, and addition and subtraction of 0-9 objects.
Recordkeeping available - No

Ratings - HS-43

Title - **Easy Street**
Publisher - MindPlay
Hardware Requirements - Apple II line, IBM, Macintosh
Additional Hardware -Joystick or mouse optional; Echo speech synthesizer optional
Software Type - Simulation
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - Yes(2,3)
Classification - Yes(2,3)
Seriation - No
Spatial Relations - Yes(4,8)
Time - Yes(3)
Description - Child moves a male character down a street past various storefronts in search of special objects.
Recordkeeping available - No
Ratings - HS-84

Title - **Eli's Shapes, Sizes, and Colors**
Publisher - Simage, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - No
Classification - Yes
Seriation - Yes
Spatial Relations - No
Time - No
Description - 700 problems of graduated difficulty in study of numerals, shapes, sizes and colors, and 4 games.
Recordkeeping available - Yes
Ratings - None

Title - **Ernie's Big Splash**
Publisher - HiTech Expressions
Hardware Requirements - Apple II line, IBM, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 6
Topics Covered -
Number - No
Classification - No

Seriation - No
Spatial Relations - Yes(4,7)
Time - No
Description - Using arrow keys, child builds a path that moves Rubber Duckie from his soap dish to Ernie's bathtub.
Recordkeeping available - No
Ratings - HS-45

Title - **Estimation**
Publisher - Lawrence Hall of Science
Hardware Requirements - Apple II line
Additional Hardware - No
Software Type - Skills practice
Audience - Normal children
Age - 4 - 6
Topics Covered -
Number - Yes(5,6)
Classification - No
Seriation - No
Spatial Relations - No
Time - Yes(1,3,4)
Description - 3 activities with estimation skills with nonstandard units using visual inspection.
Recordkeeping available - No
Ratings - HS-78

Title - **Exploring Your World: The Weather and All About You**
Publisher - Grolier Electronic Publishing
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - No
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - Yes(2,4,5)
Time - No
Description - Child selects a weather picture and then dresses a male or female character appropriately, selecting clothes and moving them to appropriate body part.
Recordkeeping available - No
Ratings - HS-51

Title - **EZ Logo**
Publisher - MECC
Hardware Requirements - Apple II line
Additional Hardware - Keyboard stickers (included)

Software Type - Simulation (Microworld)
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - Yes(1,3,5)
Classification - No
Seriation - No
Spatial Relations - Yes(1,4,7,8)
Time - No
Description - 2 levels; 1 key commands. Allows young children to create simple procedures and incorporate them into pictures.
Recordkeeping available - No
Ratings - HS-74

Title - **First Numbers: First Words**
Publisher - Educational Activities, Inc.
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - Yes(2,3)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 2 activities: Child duplicates a set or counts number in the set and enters correct numeral.
Recordkeeping available - No
Ratings - HS-41

Title - **First Shapes**
Publisher - First Byte, Inc.
Hardware Requirements - Apple IIGS, Macintosh, Amiga, Atari ST
Additional Hardware - Mouse
Software Type - Tutorial
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - No
Classification - Yes(1)
Seriation - Yes(1)
Spatial Relations - Yes(8)
Time - No
Description - Child can design a toy out of shapes, match shapes, and find smallest (medium, largest) circle (square, triangle, etc) out of 3.
Recordkeeping available - No

Ratings - HS-75

Title - **Fish Scales**
Publisher - DLM
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
    Number - Yes(1,3,4,6)
    Classification - No
    Seriation - No
    Spatial Relations - No
    Time - No
Description - 6 game activities to reinforce measurement concepts.
Recordkeeping available - No
Ratings - HS-78

Title - **Fruit Tree/Gumball**
Publisher - BeCi Software
Hardware Requirements - Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 2 - 6
Topics Covered -
    Number - Yes(3,4)
    Classification - No
    Seriation - No
    Spatial Relations - No
    Time - No
Description - 2 activities: Child counts gumballs (up to 35) and does addition and subtraction problems.
Recordkeeping available - No
Ratings - HS-28

Title - **Fun With Directions**
Publisher - Mindscape, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
    Number - No
    Classification - No
    Seriation - No
    Spatial Relations - Yes(4)

Time - Yes(6)
Description - Child selects nodding or shaking head to indicate if objects are in line, facing the same direction or in sequence (e.g. egg, chick, chicken)
Recordkeeping available - ?
Ratings - HS-62

Title - **Fun With Numbers**
Publisher - Wescott Software
Hardware Requirements - IBM
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 2 - 6
Topics Covered -
Number - Yes(3,4,8)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 5 games provide experiences in counting, and adding and subtracting with objects, all with sums less than 18.
Recordkeeping available - ? (but teacher modification capability)
Ratings - HS-59

Title - **Getting Ready to Read and Add**
Publisher - Sunburst Communications, Inc.
Hardware Requirements - Apple II line, IBM, Commodore 64, Atari
Additional Hardware - Joystick or game paddles optional
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(3,4)
Classification - Yes(2)
Seriation - No
Spatial Relations - No
Time - No
Description - 6 matching activities for shapes, letters, and numerals.
Recordkeeping available - ? (but teacher modification capability)
Ratings - HS-63

Title - **Grover's Animal Adventure**
Publisher - HiTech Expressions
Hardware Requirements - Apple II line, IBM, Commodore 64
Additional Hardware - Joystick
Software Type - Skills practice

Audience - Normal children
Age - 4 - 6
Topics Covered -
Number - No
Classification - Yes(2)
Seriation - No
Spatial Relations - No
Time - No
Description - Child uses joystick to move Grover to 1 of 4 environments. Each environment is divided into land, sky, and water areas. Child must place animal in the correct area.
Recordkeeping available - No
Ratings -HS-76

Title - **Happy Birthday, Pockets**
Publisher - World Book, Inc.
Hardware Requirements - IBM
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 5
Topics Covered -
Number - No
Classification - Yes(2)
Seriation - No
Spatial Relations - No
Time - No
Description - 8 activities in sorting and matching
Recordkeeping available - No
Ratings - HS-71

Title - **How to Weigh an Elephant**
Publisher - Learning Technologies, Inc.
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - Yes(1)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 3 activities in which the child observes how far a boat sinks and then must select the heaviest animal or guesses which glass has the most.
Recordkeeping available - No
Ratings - HS-42

Title - **Inside Outside Opposites**
Publisher - Random House Software
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice, tutorial
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - No
Classification - Yes(1,2)
Seriation - No
Spatial Relations - Yes(8)
Time - No
Description - Child locates a shape hidden in one of 18 pictures. Correct response animates the picture and plays music. Similar to "Stickybear Shapes."
Recordkeeping available - No
Ratings - HS-76

Title - **Inside Outside Shapes**
Publisher - Random House Software
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skill practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - No
Classification - Yes(1,2)
Seriation - No
Spatial Relations - Yes(8)
Time - No
Description - Child identifies common shapes by exploring scenes in the kitchen, playground, from a hot air balloon and in an amusement park.
Recordkeeping available - No
Ratings -None

Title - **Integrated Learning System**
Publisher - Education Systems Corp.
Hardware Requirements - Apple IIGS, IBM, Macintosh
Additional Hardware - Headphones, speech synthesizer, and speech recognition
Software Type - Skills practice?
Audience - Normal children
Age - 5 - 14 (included because there are so many lessons that some of lowest may be appropriate)
Topics Covered -
Number - Yes(1,2,3,4,5,6,7,8)

Classification - Yes(1,2,3,4,5,6)
Seriation - No
Spatial Relations - No
Time - No
Description - A networked computerized math and reading curriculum containing 1800 separate lessons stored on a laser disk which can be accessed by up to 40 stations at once.
Recordkeeping available - Yes
Ratings - HS-79

Title - **Introduction to Counting**
Publisher - EduWare
Hardware Requirements - Apple II line, IBM, Atari
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - Yes(3)
Classification - Yes(1)
Seriation - Yes(1)
Spatial Relations - No
Time - No
Description - Sequence of 8 counting activities from selecting a set which corresponds to a number to subtraction.
Recordkeeping available - Yes
Ratings - HS-66

Title - **Kieran**
Publisher - Ohm Software Company
Hardware Requirements - Macintosh
Additional Hardware - Mouse
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(3)
Classification - No
Seriation - No
Spatial Relations - Yes(2)
Time - Yes(9)
Description - 8 activities include: matching a set and a numeral, and choosing a clock face and hearing the time.
Recordkeeping available - No
Ratings - HS-70

Title - **Kinder Koncepts MATH**
Publisher - Queue, Inc.

Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - Yes(1,2,3,4,5,6,7,8)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 15 activities cover estimating length, using units of measurement, counting, and numeral recognition.
Recordkeeping available - ?
Ratings - HS-57

Title - **Kinderlogo**
Publisher - Krell Software Corp.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Tutorial
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - Yes(1,3,5)
Classification - No
Seriation - No
Spatial Relations - Yes(1,4,7,8)
Time - No
Description - A step by step introduction to LOGO. Runs with all versions of M.I.T. LOGO.
Recordkeeping available - No
Ratings - Curriculum Review-+

Title - **Kindercomp Golden Edition**
Publisher - Spinnaker Software Corporation
Hardware Requirements - Apple II line, IBM
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - Yes(3)
Classification - Yes(2)
Seriation - No
Spatial Relations - No
Time - No

Description - 8 activities including counting (up to 30), number sequence, counting by 2's, 3's, etc, and addition with sums up to 18.
Recordkeeping available - No
Ratings - HS-70

Title - **Kindermath II**
Publisher - Houghton Mifflin Co.
Hardware Requirements - Apple II line
Additional Hardware - Joystick, Echo speech synthesizer
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - Yes(1,2,3,4,5,8)
Classification - Yes(2)
Seriation - No
Spatial Relations - Yes(8)
Time - No
Description - 10 disks covering 90 objectives from same and different to addition and subtraction with sums less than 10.
Recordkeeping available - Yes
Ratings - HS-57

Title - **Knowing Numbers**
Publisher - Mindscape, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(1,3,7)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - Counting, addition, and subtraction activities. Nodding and shaking heads to decide if a group matches a numeral, which group has "more" and if the sum of two groups equals a third.
Recordkeeping available - Yes
Ratings - HS-67

Title - **Learning About Numbers**
Publisher - C&C Software
Hardware Requirements - Apple II line

Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(8)
Classification - No
Seriation - No
Spatial Relations - No
Time - Yes(9)
Description - Activities in counting, telling time and basic math facts at various difficulty levels
Recordkeeping available - Yes
Ratings - HS-78

Title - **Learning with Fuzzywomp**
Publisher - Sierra On-Line
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - Joystick
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(3,4)
Classification - Yes(2)
Seriation - No
Spatial Relations - No
Time - No
Description - 4 activities provide opportunities for counting and matching at multiple difficulty levels.
Recordkeeping available - No
Ratings - HS-73

Title - **Learning with Leeper**
Publisher - Sierra On-Line
Hardware Requirements - Apple II line, Commodore 64, Atari
Additional Hardware - Yes
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(4)
Classification - Yes(2)
Seriation - No
Spatial Relations - No
Time - No
Description - Similar to "Learning with Fuzzwomp." Games which focus on matching and counting skills among others.
Recordkeeping available - No
Ratings - HS-69; EPIE-Recommended with reservations

Title - **Let's Go Fishing**
Publisher - Learning Technologies, Inc.
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
    Number - Yes(3)
    Classification - Yes(2)
    Seriation - No
    Spatial Relations - No
    Time - No
Description - 2 counting and addition activities.
Recordkeeping available - No
Ratings - HS-36

Title - **Lion's Workshop**
Publisher - Learning Technologies, Inc.
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
    Number - No
    Classification - Yes(2)
    Seriation - No
    Spatial Relations - No
    Time - No
Description - 2 activities provide opportunities for practice in matching and identifying how things are the same or different.
Recordkeeping available - No
Ratings - HS-49

Title - **Make a Match**
Publisher - Springboard Publications
Hardware Requirements - Apple II line, IBM, Atari
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 2.5 - 6
Topics Covered -
    Number - No
    Classification - Yes(1,2)
    Seriation - No
    Spatial Relations - No

Time - No
Description - 4 activities in which child presses a key to indicate when a match in shape, color, or size has been made.
Recordkeeping available - No
Ratings - HS-75

Title - **Mary Marvel...the Garden**
Publisher - DIL International
Hardware Requirements - Apple II line
Additional Hardware - WonderWorker touch tablet
Software Type - Skills practice
Audience - Normal children
Age - 2 - 7
Topics Covered -
Number - No
Classification - Yes(1)
Seriation - No
Spatial Relations - Yes(7)
Time - Yes(6)
Description - 10 disks entitled: My Own Garden, Trees & Seasons, Gardening Tools, Parts of a Flower, Pollination, Water, Gardening, Growing a Bean Seed, Vegetables, and Flowers.
Recordkeeping available - No
Ratings - HS-62

Title - **Match-On-A-Mac**
Publisher - Teach Yourself by Computer
Hardware Requirements - Macintosh
Additional Hardware - Mouse
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - Yes(1,3,4)
Classification - Yes(2)
Seriation - No
Spatial Relations - Yes(8)
Time - No
Description - Activities for matching shapes, letters, short words, quantities and numerals with quantities.
Recordkeeping available - Yes (and teacher modification capability)
Ratings - HS-79

Title - **Math and Me**
Publisher - Davidson and Associates, Inc.
Hardware Requirements - Apple II line, Apple IIGS, IBM
Additional Hardware - Mouse

Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(1,3,4,7)
Classification - Yes(2)
Seriation - Yes(4)
Spatial Relations - No
Time - No
Description - 12 activities covering shape matching, number recognition, patterns, numerical order, and addition with objects and numbers.
Recordkeeping available - No
Ratings - HS-78

Title - **Math Concepts Level P**
Publisher - IBM Educational Systems
Hardware Requirements - IBM
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 5
Topics Covered -
Number - Yes(1,3,4,6,7,8)
Classification - Yes(2)
Seriation - Yes(3)
Spatial Relations - Yes(8)
Time - No
Description - The first in IBM's math concepts series. Wide range of content.
Recordkeeping available - Yes
Ratings - HS-73

Title - **MacKids Preschool Disk**
Publisher - Nordic Software, Inc.
Hardware Requirements - Macintosh
Additional Hardware - Mouse
Software Type - Skills practice, drill
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - Yes
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 2 math activities on this disk include practice in counting and a connect the dots activity.
Recordkeeping available - No

Ratings - None

Title - **MacKids Shapeworks**
Publisher - Nordic Software, INc.
Hardware Requirements - Macintosh
Additional Hardware - Mouse
Software Type - Skills practice, drill
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - No
Classification - Yes
Seriation - Yes
Spatial Relations - No
Time - No
Description - 4 activities provide practice with shape recognition and patterns.
Recordkeeping available - No
Ratings - None

Title - **Milk Bottles**
Publisher - Island Software
Hardware Requirements - Apple II line
Additional Hardware - Light pen
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(1)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - Child uses light pen to identify full milk bottle from a group of milk bottles.
Recordkeeping available - No
Ratings - HS-39

Title - **Muppets on Stage**
Publisher - Sunburst Communications, Inc.
Hardware Requirements - Apple II line, IBM, Commodore 64
Additional Hardware - Muppet Learning Keys
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(4)
Classification - No

Seriation - No
Spatial Relations - No
Time - No
Description - 3 activities provide experience with letters, colors, numerals, and number.
Recordkeeping available - No
Ratings - HS-73

Title - **Muppetville**
Publisher - Sunburst Communications, Inc.
Hardware Requirements - Apple II line
Additional Hardware - Muppet Learning Keys, Touch Window, Mouse
Software Type - Skills practice
Audience - Normal children
Age - 4 - 6
Topics Covered -
Number - Yes(3,4)
Classification - Yes(2)
Seriation - No
Spatial Relations - No
Time - No
Description - 6 activities provide practice with shapes, colors and numbers at various difficulty levels.
Recordkeeping available - ? (but teacher modification capability)
Ratings - HS-87

Title - **Number BeCi**
Publisher - BeCi Software
Hardware Requirements - Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(3)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - Timed counting activity in which child counts like or unlike objects at one of 3 difficulty levels.
Recordkeeping available - No
Ratings - HS-29

Title - **Number Circus**
Publisher - Dynacorp
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice, drill

Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - Yes
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - Drill and Practice covering counting, addition, and subtraction.
Recordkeeping available - No
Ratings - None

Title - **Number Farm**
Publisher - DLM
Hardware Requirements - Apple II line, IBM, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(3,4,5,8)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 6 games present multiple counting experiences.
Recordkeeping available - No
Ratings - HS-78

Title - **Numbers**
Publisher - Lawrence Hall of Science
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 6
Topics Covered -
Number - Yes(3,4,8)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 2 game format activities in counting and recognizing numerals.
Recordkeeping available - No
Ratings - HS-58

Title - **Numbers Count**

Publisher - Polarware, Inc.
Hardware Requirements - Apple II line, IBM, Commodore 64
Additional Hardware - Mouse, joystick
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
    Number - No
    Classification - Yes(1,4)
    Seriation - No
    Spatial Relations - Yes(4)
    Time - No
Description - A coloring program with 30 number pictures.
Recordkeeping available - No
Ratings - HS-80

Title - **Observation and Classification**
Publisher - Hartley Courseware, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 5
Topics Covered -
    Number - No
    Classification - Yes(1,2,4)
    Seriation - No
    Spatial Relations - No
    Time - No
Description - 3 classification activities: selecting which object is different, and selecting which objects are the same size or belong to the same group.
Recordkeeping available - ? (but teacher modification capability)
Ratings - HS-80

Title - **Odd One Out**
Publisher - Sunburst Communications, Inc.
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
    Number - No
    Classification - Yes(1,2,4)
    Seriation - No
    Spatial Relations - No
    Time - No
Description - 5 games based on selecting which of 4 objects does not belong.

Recordkeeping available - ?
Ratings - HS-74

Title - **Ollie and Seymour**
Publisher - Hartley Courseware, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Simulation
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - No
Classification - Yes(2)
Seriation - No
Spatial Relations - Yes(4,6,8)
Time - Yes(1)
Description - Simulation in which child uses arrow keys to move "Ollie around a park and through the streets where he can practice safe street crossing, obeying traffic signals or games. Games involve shape and color matching and stacking and counting blocks.
Recordkeeping available - No
Ratings - HS-77

Title - **Ordering/Sequencing**
Publisher - Aquarius People Materials
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Tutorial, Drill
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - No
Classification - No
Seriation - Yes(2)
Spatial Relations - No
Time - No
Description - Minimal interaction Information is presented but little opportunity for student input.
Recordkeeping available - No
Ratings - HS-38

Title - **Pals Around Town**
Publisher - CBS Software
Hardware Requirements - Apple II line, IBM, Commodore 64
Additional Hardware - Joystick
Software Type - Skills practice
Audience - Normal children
Age - 4 - 6

Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - Yes(4,6,7)
Time - No
Description - Child uses joystick to explore and add objects to 1 of 5 scenes (a playground, a schoolroom, etc).
Recordkeeping available - No
Ratings - HS-73

Title - **Patterns and Sequences**
Publisher - Hartley Courseware, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - No
Classification - Yes(1)
Seriation - Yes(1)
Spatial Relations - No
Time - No
Description - 4 activities in classification and ordering objects. Software is part of an activity kit which provides other materials for matching and counting activities as well.
Recordkeeping available - No
Ratings - HS-72

Title - **Peter and the Wolf Music**
Publisher - Spinnaker Software Corporation
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - Joystick, Echo speech synthesizer
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - No
Classification - Yes(2)
Seriation - Yes(1,2,4)
Spatial Relations - No
Time - No
Description - 6 music games give practice distinguishing tones, ordering notes by pitch and recreating simple melodies. (Note: included here as a reminder that there are other dimensions on which things can be classified or ordered besides those which are visible.)

Recordkeeping available - No
Ratings - HS-77

Title - **Pockets and Her New Sneakers**
Publisher - World Book, Inc.
Hardware Requirements - IBM
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 5
Topics Covered -
Number - No
Classification - Yes(2)
Seriation - No
Spatial Relations - No
Time - No
Description - 8 simple games in which children match flowers, buttons, fish, toys or shoes.
Recordkeeping available - No
Ratings - HS-62

Title - **Pockets Goes on a Picnic**
Publisher - World Book, Inc.
Hardware Requirements - IBM
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 5
Topics Covered -
Number - No
Classification - Yes(2)
Seriation - No
Spatial Relations - Yes(1)
Time - No
Description - 6 activities in which child puts things together by category or matches parts (of an insect) to make a whole.
Recordkeeping available - No
Ratings - HS-61

Title - **Pockets Goes on Vacation**
Publisher - World Book, Inc.
Hardware Requirements - IBM
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 5
Topics Covered -
Number - No

Classification - No
Seriation - No
Spatial Relations - Yes(4)
Time - No
Description - Child moves objects in/out, above/below, left/right, etc.
Recordkeeping available - No
Ratings - HS-63

Title - **Pockets Goes to the Carnival**
Publisher - World Book, Inc.
Hardware Requirements - IBM
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 5
Topics Covered -
Number - Yes(2,3)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 6 games in which child matches or counts.
Recordkeeping available - No
Ratings - HS-68

Title - **Pockets Leads the Parade**
Publisher - World Book, Inc.
Hardware Requirements - IBM
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 5
Topics Covered -
Number - No
Classification - Yes(2)
Seriation - Yes(2)
Spatial Relations - No
Time - No
Description - 6 games, among which are several in which child copies or recognizes patterns.
Recordkeeping available - No
Ratings - HS-75

Title - **Preschool Disk 2**
Publisher - Nordic Software
Hardware Requirements - Macintosh
Additional Hardware - None
Software Type - Skills practice

Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - Yes(3,7)
Classification - Yes(2)
Seriation - No
Spatial Relations - No
Time - No
Description - 4 game activities in which student matches shapes and counts.
Recordkeeping available - No
Ratings - HS-75

Title - **Preschool IQ Builder I (and II)**
Publisher - PDI Software
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - No
Classification - Yes(2)
Seriation - No
Spatial Relations - No
Time - No
Description - Child matches objects and determines if objects on the screen are the same or different.
Recordkeeping available - No
Ratings - HS-38(43)

Title - **Puss in Boot**
Publisher - Island Software
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - None
Software Type - Drill
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - Yes(4)
Time - No
Description - Practice with 14 positional concepts such as below and above, in and out.
Recordkeeping available - No
Ratings - HS-34; EPIE-Not recommended but may meet some needs

Title - **Puzzle Master**
Publisher - Springboard Publications
Hardware Requirements - Apple II line, IBM, Commodore 64
Additional Hardware - Joystick optional
Software Type - Skills practice
Audience - Normal children
Age - 4 - up
Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - Yes(1,2)
Time - No
Description - Child selects 1 of 30 pictures which can be scrambled and reassembled using icons. Varying difficulty levels. (Note: This in included despite the fact that it has an unlimited upper age limit because it appeared to be a unique product and appropriate for preschool children.)
Recordkeeping available - No
Ratings - HS-79

Title - **R.J.'s Switch Progressions**
Publisher - R.J. Cooper, & Associates
Hardware Requirements - Apple II line
Additional Hardware - Switch
Software Type - Skills practice
Audience - Children with motor impairments
Age - 2 - up
Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - No
Time - Yes(1,6)
Description - Child controls an 8 step animated sequence such as crossing the street, getting up, catching the bus, and changing TV channels.
Recordkeeping available - No
Ratings - HS-65

Title - **The Rabbit Scanner**
Publisher - ECS
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children ?
Age - 2 - 5
Topics Covered -
Number - No

Classification - Yes(2)
Seriation - No
Spatial Relations - No
Time - Yes(1,3)

Description - Provides practice in scanning as child watches a rabbit move across the screen and presses a key when it reaches a certain point.

Recordkeeping available - No
Ratings - HS-67

Title - **Run Rabbit Run**
Publisher - ECS
Hardware Requirements - Apple II line
Additional Hardware - Joystick or game paddles optional
Software Type - Skills practice
Audience - Normal children ?
Age - 4 - 7
Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - No
Time - Yes(1,3,5)

Description - Child practices visual skills and timing by helping a rabbit through an obstacle course.

Recordkeeping available - ? (but teacher modification capability)
Ratings - HS-70

Title - **Same or Different**
Publisher - Learning Technologies, Inc.
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - No
Classification - Yes(1,2)
Seriation - No
Spatial Relations - No
Time - No

Description - Child determines which object is different and matches objects.

Recordkeeping available - No
Ratings - HS-55

Title - **Shape & Color Rodeo**
Publisher - DLM
Hardware Requirements - Apple II line, IBM, Commodore 64

Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - No
Classification - Yes(1)
Seriation - No
Spatial Relations - No
Time - No
Description - 6 activities in which child matches shapes or colors and looks for hidden shapes in a rodeo picture.
Recordkeeping available - No
Ratings - HS-73

Title - **Shape Games**
Publisher - BeCi Software
Hardware Requirements - Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - No
Classification - Yes(2)
Seriation - Yes(4)
Spatial Relations - No
Time - No
Description - 2 activities in matching and pattern completion at various difficulty levels.
Recordkeeping available - No
Ratings - HS-44

Title - **Shapes & Patterns**
Publisher - Mindscape, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - No
Classification - Yes(1,2)
Seriation - Yes(2)
Spatial Relations - No
Time - No
Description - Child uses nodding/shaking heads to decide if objects match or a pattern is correct.
Recordkeeping available - Yes (and teacher modification capability)
Ratings - HS-66

Title - **Shutterbug's Patterns**
Publisher - Learning Technologies, Inc.
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
    Number - No
    Classification - Yes(2)
    Seriation - No
    Spatial Relations - No
    Time - No
Description - Pattern completion activities.
Recordkeeping available - No
Ratings - HS-36

Title - **Size and Logic**
Publisher - Hartley Courseware, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
    Number - No
    Classification - Yes(1)
    Seriation - Yes(1,2,4)
    Spatial Relations - No
    Time - No
Description - 4 games in which child matches objects by size, selects the object that comes next in a series, or creates a matching set.
Recordkeeping available - No
Ratings - HS-77

Title - **SocPix**
Publisher - American Guidance Service
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
    Number - No
    Classification - Yes(2,4)
    Seriation - No

Spatial Relations - No
Time - No
Description - 3 activities in which child decides if an object belongs to a given category.
Recordkeeping available - Yes
Ratings - HS-61

Title - **Spaceship Lost**
Publisher - Educational Activities, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Tutorial
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - Yes
Time - No
Description - Based on the work of Piaget, focuses on two stages of spatial development: Use of directional concepts from the child's point of view and from another's point of view.
Recordkeeping available - No
Ratings - None

Title - **Space Waste Race**
Publisher - Sunburst Communications, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - Yes(3,4)
Classification - No
Seriation - No
Spatial Relations - Yes(4)
Time - No
Description - Theme related drill and practice in counting, number recognition, and spatial concepts.
Recordkeeping available - No
Ratings - HS-48

Title - **Spatial Relations: 3 Geometric Shapes**
Publisher - Aquarius People Materials
Hardware Requirements - Apple II line
Additional Hardware - None

Software Type - Skills practice, drill
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - Yes
Time - No
Description - Activities to practice recognizing and constructing geometric shapes.
Recordkeeping available - No
Ratings - None

Title - **Stepping Stones Level 1 (and Level 2)**
Publisher - Compu-Teach
Hardware Requirements - Apple II line, Macintosh, IBM
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 2 - 7
Topics Covered -
Number - Yes(2,3,4)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - Activities in counting.
Recordkeeping available - No
Ratings - HS-59(58)

Title - **Stickybear Numbers**
Publisher - Weekly Reader Software
Hardware Requirements - Apple II line, IBM, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - Yes(3,4,7)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - 25 counting activities.
Recordkeeping available - No
Ratings - HS-64

Title - **Stickybear Opposites**
Publisher - Weekly Reader Software

Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - No
Classification - No
Seriation - Yes(1)
Spatial Relations - Yes(4)
Time - No
Description - 21 activities using antonym pairs such as up/down, full/empty, and in front/behind
Recordkeeping available - No
Ratings - HS-73; EPIE-Recommended with reservations

Title - **Stickybear Shapes**
Publisher - Weekly Reader Software
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - Joystick or game paddles optional
Software Type - Drill
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - No
Classification - No
Seriation - No
Spatial Relations - Yes(8)
Time - No
Description - 3 activities to reinforce shape recognition: name a shape, find a shape, and pick a shape.
Recordkeeping available - No
Ratings - HS-70; EPIE-Recommended with reservations

Title - **The Sweet Shop**
Publisher - D.C.Heath & Company
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - Yes(3)
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - Activities to match numerals with a number of objects.
Recordkeeping available - No

Ratings - HS-54

Title - **Talk About a Walk**
Publisher - Queue, Inc.
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice
Audience - Normal children
Age - 4 - 6
Topics Covered -
Number - No
Classification - Yes(2)
Seriation - No
Spatial Relations - Yes(6)
Time - No
Description - 2 activities in which the child must determine if household objects are in the appropriate room (classifying by storage location or use location).
Recordkeeping available - No
Ratings - HS-56

Title - **Teddy Bears Counting Fun**
Publisher - Micro Learningware
Hardware Requirements - Apple II line
Additional Hardware - None
Software Type - Skills practice, drill
Audience - Normal children
Age - 4 - 6
Topics Covered -
Number - Yes
Classification - No
Seriation - No
Spatial Relations - No
Time - No
Description - Practice in counting and one-to-one correspondence.
Recordkeeping available - No
Ratings - None

Title - **Tonk in the Land of Buddy-Bots**
Publisher - Mindscape, Inc.
Hardware Requirements - Apple II line, IBM, Commodore 64, Atari
Additional Hardware - Joystick optional
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - No
Classification - No
Seriation - No

Spatial Relations - Yes(1,5,7)
Time - No

Description - Child moves Tonk through a 65 screen landscape filled with robot parts, sky holes and enemy soldiers. Along the way, Tonk can stop to play 1 of 6 games on memory, matching, and spatial relations.

Recordkeeping available - No
Ratings - HS-56

Title - **Touch and Match**
Publisher - ECS
Hardware Requirements - Apple II line
Additional Hardware - Touch Window required
Software Type - Skills practice
Audience - Normal children
Age - 3 - 6
Topics Covered -
Number - No
Classification - Yes(2,4)
Seriation - No
Spatial Relations - No
Time - No

Description - Child touches the screen to identify identical, associated or different pictures among 4 that are shown.

Recordkeeping available - No
Ratings - HS-65

Title - **Up & Add "Em**
Publisher - Spinnaker Software Corporation
Hardware Requirements - Apple II line, IBM, Commodore 64
Additional Hardware - Joystick optional
Software Type - Skills practice
Audience - Normal children
Age - 3 - 7
Topics Covered -
Number - Yes(1,3,4,7)
Classification - No
Seriation - No
Spatial Relations - No
Time - No

Description - Child completes a rainbow by matching numbers to sets, sets to sets, and doing simple addition and subtraction problems.

Recordkeeping available - No
Ratings - HS-75

Title - **Webster's Numbers**

Publisher - EduWare
Hardware Requirements - Apple II line, Commodore 64
Additional Hardware - Joystick or game paddles required
Software Type - Skills practice
Audience - Normal children
Age - 4 - 7
Topics Covered -
Number - Yes(3,4)
Classification - No
Seriation - No
Spatial Relations - Yes(1,2,4)
Time - No
Description - 4 games in which child moves a character or shape to reach numbers in order, match numerals to sets, match a model, or arrange blocks in numerical order.
Recordkeeping available - No
Ratings - HS-67; EPIE-Recommended with reservations

Title - **Words and Concepts (and Words and Concepts II and III)**
Publisher - Laureate Learning Systems
Hardware Requirements - Apple II line
Additional Hardware - Touch Window or Switch optional; Echo speech synthesizer required.
Software Type - Skills practice
Audience - Language delayed and/or motor impaired children
Age - 3 - up
Topics Covered -
Number - No
Classification - Yes(1,2,4)
Seriation - No
Spatial Relations - No
Time - No
Description - Shows 3 objects and, using the Touch Window, switch, or number keys, child responds to a question voiced by the Echo. Provides practice identifying, categorizing, associating and discriminating 40 common nouns.
Recordkeeping available - Yes (and teacher modification capability)
Ratings - HS-80

Appendix D

Telephone Interview Instrument

Preschool Math & Science SBIR Telephone Interview

INTERVIEWEE _____

DATE _____ **PHONE NO.** _____

AFFILIATION _____ **EXPERTISE** _____

ADDRESS _____

_____

_____

I. DEMOGRAPHIC BACKGROUND

1. Experience in early childhood education?	☐ YES _____ YEARS ☐ NO
2. Experience in special education?	☐ YES _____ YEARS WITH COGNITIVELY IMPAIRED PRESCHOOLERS? ☐ YES ☐ NO ☐ NO
3. Experience in math/science education?	☐ YES _____ YEARS _____ WHAT AGE GROUPS? _____ ☐ NO
4. Experience in computers/software development for young children?	☐ YES _____ YEARS ☐ AS A REVIEWER? ☐ AS A DEVELOPER? ☐ AS A TEACHER/ADMINISTRATOR? ☐ NO
5. Experience in videodisc development?	☐ YES _____ YEARS _____ WHAT AGE GROUPS? _____ WITH HANDICAPPED CHILDREN? ☐ YES ☐ NO ☐ NO

II. DESIGN AND APPROACH

1. How applicable do you think research on software for preschoolers is to the use of videodisc with 3 to 5 year olds?

2. How long do you think we can expect mildly cognitively impaired 3 to 5 year olds to sit at a computer using a videodisc?

   2a. Would there be any appreciable difference in the time that nonhandicapped children could spend at a computer?

3. What can be done to maximize the children's interest in using the videodisc?

   3a. Are you aware of any research on the use of videodisc as a motivational tool for young children?

4. What suggestions would you make in terms of graphics? For example, should there be more video and less computer graphics? What about use of animation? Does it help or is it distracting? What about use of written words as labels, etc.?

II. DESIGN AND APPROACH [continued]

5. Should all learners be presented with a variety of strategies or should one strategy be primary and alternative strategies be presented only to those who don't get the first way?

6. Should there be recordkeeping system? If so, what information, other than number of attempts, should be provided?

7. What should be the teacher's role?

8. What techniques/strategies are you familiar with that you think would enhance this effort?

III. CONTENT

1. Do you think the proposed videodisc should be used for introducing content, as a reinforcer of content already learned, or for a combination of both?

2. Do you have any suggestions for integrating the videodisc into ongoing preschool programs?

3. Do you think we can use the same concepts as foundations for both math and science, or do you feel there should be a delineation between the two?

4. How many concepts is it feasible to include? Would you suggest fewer concepts in more depth or multiple concepts at an introductory level?

III. CONTENT [continued]

5. Here are some topics we've been considering focusing on in the videodisc:

CLASSIFICATION	[including observing attributes, sorting, and comparing and contrasting]
SERIALIZATION	[arranging things according to properties such as height, weight, and temperature]
NUMBER	[one-to-one correspondence, counting
TIME	[units of time, sequencing of time]

How do you react to these? Do you agree with this approach, or would you go another route? What other topics would you feel it's important to include as *foundations* for math and science?

IV. ADDITIONAL THOUGHTS AND RECOMMENDATIONS

Appendix E

Telephone Interviews of Experts

Preschool Math & Science SBIR Telephone Interview

INTERVIEWEE Warren Buckleitner

DATE 11/15/89 PHONE NO. (313) 485-2000

AFFILIATION Educational Computer EXPERTISE Early childhood software

~~ADDRESS~~ Consultant

High/Scope

I. DEMOGRAPHIC BACKGROUND

1. Experience in early childhood education?	☑ YES 5 YEARS ☐ NO
2. Experience in special education?	☐ YES _____ YEARS WITH COGNITIVELY IMPAIRED PRESCHOOLERS? ☐ YES ☐ NO ☑ NO
3. Experience in math/science education?	☑ YES 1 YEARS _____ WHAT AGE GROUPS? taught junior high science ☐ NO
4. Experience in computers/software development for young children?	☑ YES 5 YEARS ☑ AS A REVIEWER? ☑ AS A DEVELOPER? ☐ AS A TEACHER/ADMINISTRATOR? ☐ NO
5. Experience in videodisc development?	☐ YES _____ YEARS _____ WHAT AGE GROUPS? _____ WITH HANDICAPPED CHILDREN? ☐ YES ☐ NO ☑ NO

II. DESIGN AND APPROACH

1. How applicable do you think research on software for preschoolers is to the use of videodisc with 3 to 5 year olds?

Quite applicable. Although there is a body of research on how children use software, we know that what children can do depends on what they are given. Any subject can, however, be taught.

2. How long do you think we can expect mildly cognitively impaired 3 to 5 year olds to sit at a computer using a videodisc?

3 year olds - up to 10 minutes
4 year olds - 10-15 minutes
5 year olds - up to 30 minutes, if the program is interactive and open-ended

2a. Would there be any appreciable difference in the time that nonhandicapped children could spend at a computer?

No difference

3. What can be done to maximize the children's interest in using the videodisc?

1) give the child control
2) it's important that the child knows he can escape at any time
3) keep the program crisp and moving

3a. Are you aware of any research on the use of videodisc as a motivational tool for young children?

N/A

4. What suggestions would you make in terms of graphics? For example, should there be more video and less computer graphics? What about use of animation? Does it help or is it distracting? What about use of written words as labels, etc.?

Use language as contextual background. Keep language appropriate to the child's developmental level, e.g. "stop" is stop sign vs. "escape." Make sure children know what the words being used mean.

II. DESIGN AND APPROACH [continued]

5. Should all learners be presented with a variety of strategies or should one strategy be primary and alternative strategies be presented only to those who don't get the first way?

Let a child go as high as he can without stopping. Too much repetition makes a program sluggish.
Branching is an art. It's only good if it's done right. If a loop isn't relevant and it's repetitious, it's a detriment.

6. Should there be recordkeeping system? If so, what information, other than number of attempts, should be provided?

Yes. There should be a prescription ~~menu~~, in which the teacher presents the child with only a limited number of choices — all of which would be customized to fit the child's interests.

7. What should be the teacher's role?

She should be a facilitator making diagnostic decisions. The user's guide for the teacher should be simple and contain no theory. She should do the customization and allow the child and the machine to do the interaction.

8. What techniques/strategies are you familiar with that you think would enhance this effort?

1) involve child with concepts, e.g. if teaching the number 3, have a child push a Key 3 train rather than hitting the "3" key
2) we know children can use a mouse
3) avoid transitions — children see like a flashlight
4) the exit icon should always be present — this gives a child control

III. CONTENT

1. Do you think the proposed videodisc should be used for introducing content, as a reinforcer of content already learned, or for a combination of both?

Both. Simulations are recommended such as BacterTacks (Hundley) and McGee (Lawrence).

2. Do you have any suggestions for integrating the videodisc into ongoing preschool programs?

Keep it as unlike TV as possible. Children need to be interacting with the program. If children stay passive for more than 10 seconds, there's a problem.

3. Do you think we can use the same concepts as foundations for both math and science, or do you feel there should be a delineation between the two?

Integration is recommended. Strong programs don't present things in a vacuum.

4. How many concepts is it feasible to include? Would you suggest fewer concepts in more depth or multiple concepts at an introductory level?

The limit is in hardware. It's better to do fewer things well. A good management system should address this.

III. CONTENT [continued]

5. Here are some topics we've been considering focusing on in the videodisc:

CLASSIFICATION	[including observing attributes, sorting, and comparing and contrasting]
SERIALIZATION	[arranging things according to properties such as height, weight, and temperature]
NUMBER	[one-to-one correspondence, counting
TIME	[units of time, sequencing of time]

How do you react to these? Do you agree with this approach, or would you go another route? What other topics would you feel it's important to include as *foundations* for math and science?

These are good topics in Piagetian terms. Suggest seeing which concepts have not been adequately covered by other programs.

IV. ADDITIONAL THOUGHTS AND RECOMMENDATIONS

Child control is key to development.

Preschool Math & Science SBIR Telephone Interview

INTERVIEWEE Jane Davidson

DATE 11/16/89 PHONE NO. (302) 451-1278

AFFILIATION Master Teacher EXPERTISE practitioner in early childhood / computers

ADDRESS University Lab School
University of Delaware

I. DEMOGRAPHIC BACKGROUND

1. Experience in early childhood education?
   - ☑ YES — 22 YEARS
   - ☐ NO

2. Experience in special education?
   - ☑ YES — 10 YEARS
     - WITH COGNITIVELY IMPAIRED PRESCHOOLERS?
       - ☑ YES (mainstreamed children)
       - ☐ NO
   - ☐ NO

3. Experience in math/science education?
   - ☑ YES — 12 YEARS
     - _____ WHAT AGE GROUPS?
       preschool
   - ☐ NO

4. Experience in computers/software development for young children?
   - ☑ YES — 5 YEARS
     - ☐ AS A REVIEWER?
     - ☐ AS A DEVELOPER?
     - ☑ AS A TEACHER/ADMINISTRATOR?
   - ☐ NO

5. Experience in videodisc development?
   - ☐ YES — _____ YEARS
     - _____ WHAT AGE GROUPS?
     - WITH HANDICAPPED CHILDREN?
       - ☐ YES
       - ☐ NO
   - ☑ NO

II. DESIGN AND APPROACH

1. How applicable do you think research on software for preschoolers is to the use of videodisc with 3 to 5 year olds?

interactive elements directly applicable; since our target audience will be slower, we should have a lot of options that are similar so that the child does not have to learn new techniques

2. How long do you think we can expect mildly cognitively impaired 3 to 5 year olds to sit at a computer using a videodisc?

5-30 minutes, depending on the options

2a. Would there be any appreciable difference in the time that nonhandicapped children could spend at a computer?

This audience has a harder time ~~waiting~~ waiting; they need a lot of repetition, but not a lot of new options

3. What can be done to maximize the children's interest in using the videodisc?

Motivation should not be a problem

3a. Are you aware of any research on the use of videodisc as a motivational tool for young children?

N/A

4. What suggestions would you make in terms of graphics? For example, should there be more video and less computer graphics? What about use of animation? Does it help or is it distracting? What about use of written words as labels, etc.?

1) There is nothing wrong with labels; they'll have little impact but they're not a distraction

2) animation should be used if appropriate; in science ~~and~~ want to show reality

* 3) there should be more computer graphics since this is the part that allows children to interact; a lower proportion of video is recommended to keep the program active

II. DESIGN AND APPROACH [continued]

5. Should all learners be presented with a variety of strategies or should one strategy be primary and alternative strategies be presented only to those who don't get the first way?

N/A

6. Should there be recordkeeping system? If so, what information, other than number of attempts, should be provided?

There should be as little emphasis as possible on recordkeeping. Teachers get trapped into looking for "right" and "wrong."

7. What should be the teacher's role?

Teacher should regard this as she does an activity center. Children should be allowed "free play" - the teacher doesn't have to be there all the time. Teacher should encourage peer teaching by letting children use the computer together. Teacher should help children see relationships.

8. What techniques/strategies are you familiar with that you think would enhance this effort?

1) Kids stay with software longer when they can have an effect on it - even if it's that they can choose a variety of things; the more options the greater the possibility the child will be involved
2) children like to do software jointly with another child; they'll stay at the computer longer if they're with someone
3) don't show a child all available options - they're likely to choose something before they're ready for it
4) make sure the software responds to the child

III. CONTENT

1. Do you think the proposed videodisc should be used for introducing content, as a reinforcer of content already learned, or for a combination of both?

Can do anything

2. Do you have any suggestions for integrating the videodisc into ongoing preschool programs?

Tie into everyday school and have activities such as sorting laundry for math. Center on themes appropriate with this age: animals, dinosaurs, trucks, transportation.

3. Do you think we can use the same concepts as foundations for both math and science, or do you feel there should be a delineation between the two?

Can combine

4. How many concepts is it feasible to include? Would you suggest fewer concepts in more depth or multiple concepts at an introductory level?

N/A

III. CONTENT [continued]

5. Here are some topics we've been considering focusing on in the videodisc:

CLASSIFICATION	[including observing attributes, sorting, and comparing and contrasting]
SERIALIZATION	[arranging things according to properties such as height, weight, and temperature]
NUMBER	[one-to-one correspondence, counting
TIME	[units of time, sequencing of time]

How do you react to these? Do you agree with this approach, or would you go another route? What other topics would you feel it's important to include as *foundations* for math and science?

Need sand too

IV. ADDITIONAL THOUGHTS AND RECOMMENDATIONS

1) Have children be active at all times - for example, ask child to do something when he sees a circle go by
2) use photographs of real things for classifying
3) Activities should coordinate with everything that is done in the classroom

Preschool Math & Science SBIR Telephone Interview

INTERVIEWEE Sue Haugland

DATE 11/15/89 PHONE NO. (314) 651 - 2952

AFFILIATION Professor of Home Economics EXPERTISE early childhood; computer software

~~ADDRESS~~ Director of Center for Preschool Studies; Director of KIDS project

S.E. Missouri State University

I. DEMOGRAPHIC BACKGROUND

1. Experience in early childhood education?	☑ YES 14 YEARS ☐ NO
2. Experience in special education?	☑ YES 4 YEARS WITH COGNITIVELY IMPAIRED PRESCHOOLERS? ☑ YES mainstreamed children ☐ NO ☐ NO
3. Experience in math/science education?	☑ YES 4 YEARS ____ WHAT AGE GROUPS? 3-5 year olds ☐ NO
4. Experience in computers/software development for young children?	☑ YES 5 YEARS ☑ AS A REVIEWER? / RESEARCHER ☐ AS A DEVELOPER? ☐ AS A TEACHER/ADMINISTRATOR? ☐ NO
5. Experience in videodisc development?	☐ YES ____ YEARS ____ WHAT AGE GROUPS? WITH HANDICAPPED CHILDREN? ☐ YES ☐ NO ☑ NO

II. DESIGN AND APPROACH

1. How applicable do you think research on software for preschoolers is to the use of videodisc with 3 to 5 year olds?

Yes, but there is a caveat: most research on software has been done in 6 weeks or less. Children develop skills over time, novelty wears off. Conclusions should therefore be viewed with caution

2. How long do you think we can expect mildly cognitively impaired 3 to 5 year olds to sit at a computer using a videodisc?

For 3-5 year olds, research shows children spend 23 minutes/week at the computer

2a. Would there be any appreciable difference in the time that nonhandicapped children could spend at a computer?

No

3. What can be done to maximize the children's interest in using the videodisc?

1) Graphics should be colorful and realistic representations
2) sound is important
3) videodisc should be centrally located so that children can talk to one-another

3a. Are you aware of any research on the use of videodisc as a motivational tool for young children?

Children are easily distracted - don't make them wait

4. What suggestions would you make in terms of graphics? For example, should there be more video and less computer graphics? What about use of animation? Does it help or is it distracting? What about use of written words as labels, etc.?

The videodisc provides an opportunity to be unique - don't turn it into a VCR. Animation should be used to trigger interaction, not as a cartoon. Labels are very useful; they should be supplemented with speech.

II. DESIGN AND APPROACH [continued]

5. Should all learners be presented with a variety of strategies or should one strategy be primary and alternative strategies be presented only to those who don't get the first way?

If a child doesn't respond correctly, respond by reinforcing in a different way. Children will get repetition on their own by going back to the program over and over. Don't build repetition in.

6. Should there be recordkeeping system? If so, what information, other than number of attempts, should be provided?

Yes. 1) How much time is spent on specific tasks.
2) Once a concept is learned, the introductory demonstration is not repeated

7. What should be the teacher's role?

Initial research says that you cannot put a ~~teacher~~ computer in a classroom and let it take care of itself. The teacher needs to be close by and accessible to the teacher. She should be there to assist if a child gets frustrated.

8. What techniques/strategies are you familiar with that you think would enhance this effort?

Be sure to tie the videodisc into normal classroom activities. Research shows children learn best when they have real objects to manipulate. Regard the computer as supplemental classroom learning — not vice versa.

III. CONTENT

1. Do you think the proposed videodisc should be used for introducing content, as a reinforcer of content already learned, or for a combination of both?

Both.

2. Do you have any suggestions for integrating the videodisc into ongoing preschool programs?

The teacher must be child-initiated

3. Do you think we can use the same concepts as foundations for both math and science, or do you feel there should be a delineation between the two?

Original thought: there should be a delineation.
Following a presentation of our thoughts: Integrative approach is strongly as well as innovative.

4. How many concepts is it feasible to include? Would you suggest fewer concepts in more depth or multiple concepts at an introductory level?

N/A

III. CONTENT [continued]

5. Here are some topics we've been considering focusing on in the videodisc:

CLASSIFICATION	[including observing attributes, sorting, and comparing and contrasting]
SERIALIZATION	[arranging things according to properties such as height, weight, and temperature]
NUMBER	[one-to-one correspondence, counting
TIME	[units of time, sequencing of time]

How do you react to these? Do you agree with this approach, or would you go another route? What other topics would you feel it's important to include as *foundations* for math and science?

Excellent choices

IV. ADDITIONAL THOUGHTS AND RECOMMENDATIONS

1) Be sure to pilot test as quickly as possible – but watch out for initial responses. Over time, responses may vary

2) Don't make it too simple. There should be expanding complexity.

Preschool Math & Science SBIR Telephone Interview

INTERVIEWEE Kathy Hebbeler

DATE 11/7/89 PHONE NO. 732-1010

AFFILIATION Education Research EXPERTISE Early childhood special education

ADDRESS Analyst/OSEP

I. DEMOGRAPHIC BACKGROUND

1. Experience in early childhood education?
   - [x] YES — 11 YEARS
   - [ ] NO

2. Experience in special education?
   - [x] YES — 11 YEARS
     - WITH COGNITIVELY IMPAIRED PRESCHOOLERS?
       - [x] YES
       - [ ] NO
   - [ ] NO

3. Experience in math/science education?
   - [x] YES — 4 YEARS
     - WHAT AGE GROUPS? 4-9 year olds
   - [ ] NO

4. Experience in computers/software development for young children?
   - [x] YES — 5 YEARS
     - [x] AS A REVIEWER? / RESEARCHER
     - [ ] AS A DEVELOPER?
     - [ ] AS A TEACHER/ADMINISTRATOR?
   - [ ] NO

5. Experience in videodisc development?
   - [ ] YES — ____ YEARS
     - ____ WHAT AGE GROUPS?
     - WITH HANDICAPPED CHILDREN?
       - [ ] YES
       - [ ] NO
   - [x] NO

II. DESIGN AND APPROACH

1. How applicable do you think research on software for preschoolers is to the use of videodisc with 3 to 5 year olds?

Potentially it's all applicable

2. How long do you think we can expect mildly cognitively impaired 3 to 5 year olds to sit at a computer using a videodisc?

It will depend on the child: from 30 seconds to 45 minutes

2a. Would there be any appreciable difference in the time that nonhandicapped children could spend at a computer?

No difference. It is the child's personality that is the key to attention - not the handicapping condition.

3. What can be done to maximize the children's interest in using the videodisc?

1) Use bright and flashy action

2) Require the child to respond on a regular basis

3a. Are you aware of any research on the use of videodisc as a motivational tool for young children?

No

4. What suggestions would you make in terms of graphics? For example, should there be more video and less computer graphics? What about use of animation? Does it help or is it distracting? What about use of written words as labels, etc.?

1) There should be a balance of video and computer graphics

2) Animation is fine, but there's a danger that it will take precedence over the point being made; it shouldn't be too glitzy

3) Using written words as labels would be a mistake. Because preschoolers can't read, writing is distracting

II. DESIGN AND APPROACH [continued]

5. Should all learners be presented with a variety of strategies or should one strategy be primary and alternative strategies be presented only to those who don't get the first way?

All learners should get a variety of approaches

6. Should there be recordkeeping system? If so, what information, other than number of attempts, should be provided?

Definitely. It should 1) Keep track of attention, ie how long the child attended 2) keep track of the types of errors 3) Keep track of successes 4) demonstrate what type of learning curve is taking place.

7. What should be the teacher's role?

Teacher needs to help children verbalize what they've done. She should talk to them about what's going on and help them to focus and reflect on processes. After a while, children can work on their own.

8. What techniques/strategies are you familiar with that you think would enhance this effort?

1) the research on cognitive strategies, ie learning to learn
2) metacognition - make children aware of what they're doing and why

III. CONTENT

1. Do you think the proposed videodisc should be used for introducing content, as a reinforcer of content already learned, or for a combination of both?

Both.

2. Do you have any suggestions for integrating the videodisc into ongoing preschool programs?

Tie the videodisc to science and math activities that are already going on in the classroom.

3. Do you think we can use the same concepts as foundations for both math and science, or do you feel there should be a delineation between the two?

Prefer they stay integrated.

4. How many concepts is it feasible to include? Would you suggest fewer concepts in more depth or multiple concepts at an introductory level?

A few at an indepth level. We need to make sure that what children understand, they understand well.

III. CONTENT [continued]

5. Here are some topics we've been considering focusing on in the videodisc:

CLASSIFICATION	[including observing attributes, sorting, and comparing and contrasting]
SERIALIZATION	[arranging things according to properties such as height, weight, and temperature]
NUMBER	[one-to-one correspondence, counting
TIME	[units of time, sequencing of time]

How do you react to these? Do you agree with this approach, or would you go another route? What other topics would you feel it's important to include as *foundations* for math and science?

Sound reasonable.

IV. ADDITIONAL THOUGHTS AND RECOMMENDATIONS

1) Help preschoolers learn to do word problems by letting them "see" numbers coming and going. We can give them the foundation for subtraction and addition.

2) Doesn't see the project as having broad applicability because of hardware and human resource problems in schools. Still, why not "shoot for the stars."

Preschool Math & Science SBIR Telephone Interview

INTERVIEWEE Dr. Daniel Shade

DATE 11/16/89 PHONE NO. (302) 451-8563

AFFILIATION Professor EXPERTISE computer software for young children

ADDRESS University of Delaware

I. DEMOGRAPHIC BACKGROUND

1. Experience in early childhood education?	☑ YES 7 YEARS ☐ NO
2. Experience in special education?	☐ YES _____ YEARS WITH COGNITIVELY IMPAIRED PRESCHOOLERS? ☐ YES ☐ NO ☑ NO
3. Experience in math/science education?	☐ YES _____ YEARS _____ WHAT AGE GROUPS? _____ ☑ NO
4. Experience in computers/software development for young children?	☑ YES 7 YEARS ☑ AS A REVIEWER? ☑ AS A DEVELOPER? ☐ AS A TEACHER/ADMINISTRATOR? ☐ NO
5. Experience in videodisc development?	☐ YES _____ YEARS _____ WHAT AGE GROUPS? _____ WITH HANDICAPPED CHILDREN? ☐ YES ☐ NO ☑ NO

II. DESIGN AND APPROACH

1. How applicable do you think research on software for preschoolers is to the use of videodisc with 3 to 5 year olds?

Very applicable: the more interactive and the more child-centered both media are, the better the products will be

2. How long do you think we can expect mildly cognitively impaired 3 to 5 year olds to sit at a computer using a videodisc?

Time will vary a great deal, depending on (1) the nature of the program, (2) the child's style of learning, and (3) how well prepared the child was for the presentation

2a. Would there be any appreciable difference in the time that nonhandicapped children could spend at a computer?

N/A

3. What can be done to maximize the children's interest in using the videodisc?

1) prepare the child 2) make it interactive 3) use a professional programmer 4) build a story on the computer, using images from the videodisc 5) give the child control over the technology

3a. Are you aware of any research on the use of videodisc as a motivational tool for young children?

N/A

4. What suggestions would you make in terms of graphics? For example, should there be more video and less computer graphics? What about use of animation? Does it help or is it distracting? What about use of written words as labels, etc.?

1) Don't want a lot of text on screen; should be icon driven

2) Computer graphics should be used to get control over the videodisc - video portion should be used as a supplement - for example, if child chooses to see something, video should be available

3) animation is very important - there should be as much as possible and it should be as good as possible

4) neither animation or music should be gratuitous

5) labeling is helpful to teachers, harmless to non-readers - text however,

II. DESIGN AND APPROACH [continued]

5. Should all learners be presented with a variety of strategies or should one strategy be primary and alternative strategies be presented only to those who don't get the first way?

3-5 year olds would be confused rather than enlightened by seeing numerous ways of looking at the same thing. Alternatives should be available to the teacher – not the children.

6. Should there be recordkeeping system? If so, what information, other than number of attempts, should be provided?

No. Recordkeeping tends to convert programs into drill and practice. Disk space could be better taken up with graphics.

7. What should be the teacher's role?

Ought to be a facilitator, not a teacher. She should introduce the hardware and set the child free. Provide "enlightened guidance" – she's available and checks in, but doesn't sit with the child at the computer a lot. She's gentle, supportive, and encouraging.

8. What techniques/strategies are you familiar with that you think would enhance this effort?

See comments section.

III. CONTENT

1. Do you think the proposed videodisc should be used for introducing content, as a reinforcer of content already learned, or for a combination of both?

Can be used in all ways.

2. Do you have any suggestions for integrating the videodisc into ongoing preschool programs?

Emphasize everyday skills the child needs to know. Include social skills, such as appropriate expressions of feeling.

3. Do you think we can use the same concepts as foundations for both math and science, or do you feel there should be a delineation between the two?

N/A

4. How many concepts is it feasible to include? Would you suggest fewer concepts in more depth or multiple concepts at an introductory level?

N/A

III. CONTENT [continued]

5. Here are some topics we've been considering focusing on in the videodisc:

CLASSIFICATION	[including observing attributes, sorting, and comparing and contrasting]
SERIALIZATION	[arranging things according to properties such as height, weight, and temperature]
NUMBER	[one-to-one correspondence, counting
TIME	[units of time, sequencing of time]

How do you react to these? Do you agree with this approach, or would you go another route? What other topics would you feel it's important to include as *foundations* for math and science?

These are good ideas. Keep it Piagetian: Piaget wouldn't flash numbers. Avoid shape recognition and counting, as there are already numerous programs for these concepts.
Look at: Talking Tiles (Bright Technologies) and Surrounding Patterns (commodore)

IV. ADDITIONAL THOUGHTS AND RECOMMENDATIONS

1) a mouse is the most accessible peripheral; joysticks are too big for 4yr olds to manipulate
2) children need training before they begin using a computer: need to know up, down, right, & left; need to know that the mouse needs to be looking at them to work (can even sew ears and tail on mouse)
3) children need to have some indication that things are happening during loading time or they will walk away thinking the machine is broken
4) computer can be social machine - it's good to put 2 or 3 chairs together; might try using two mice
5) interactive videodisc has never reached its potential - it's often used as a VCR to entertain
6) videodisc technology is so expensive, perhaps it's wiser to exploit the potential of current technology before moving on...

Preschool Math & Science SBIR Telephone Interview

INTERVIEWEE Jim Watson

DATE 11/15/89 PHONE NO. (919) 334-5307

AFFILIATION Professor of Children and Technology, University of North Carolina EXPERTISE Videodiscs and young children

ADDRESS

I. DEMOGRAPHIC BACKGROUND

1. Experience in early childhood education?	☑ YES 24 YEARS ☐ NO
2. Experience in special education?	☑ YES 8 YEARS WITH COGNITIVELY IMPAIRED PRESCHOOLERS? ☑ YES ☐ NO ☐ NO
3. Experience in math/science education?	☑ YES 1 YEARS ____ WHAT AGE GROUPS? ____ ☐ NO
4. Experience in computers/software development for young children?	☑ YES 9 YEARS ☑ AS A REVIEWER? ☑ AS A DEVELOPER? ☑ AS A TEACHER/ADMINISTRATOR? ☐ NO
5. Experience in videodisc development?	☑ YES 6 YEARS ____ WHAT AGE GROUPS? preschoolers - 1st grade WITH HANDICAPPED CHILDREN? ☐ YES ☑ NO ☐ NO

II. DESIGN AND APPROACH

1. How applicable do you think research on software for preschoolers is to the use of videodisc with 3 to 5 year olds?

It's somewhat applicable; perhaps 60% of research is transferable. What's not applicable is the use of real time motion, which is more effective in teaching young children. Videodiscs are better than software in teaching preschoolers since they can encorporate senses realistically. The only research in hypermedia is what has been (see end of form)

2. How long do you think we can expect mildly cognitively impaired 3 to 5 year olds to sit at a computer using a videodisc?

10 minutes (children should receive one 10 minute segment, but it should cover half as much information)

2a. Would there be any appreciable difference in the time that nonhandicapped children could spend at a computer?

no less than 10 minutes, no more than 20 minutes (using 10 minute segments) These numbers have been verified through research.

3. What can be done to maximize the children's interest in using the videodisc?

1) use 2 screens, one for monitor, the other for the video
2) never let a screen fade out completely
3) use smooth transitions

3a. Are you aware of any research on the use of videodisc as a motivational tool for young children?

The above research has been tested

4. What suggestions would you make in terms of graphics? For example, should there be more video and less computer graphics? What about use of animation? Does it help or is it distracting? What about use of written words as labels, etc.?

1) There should be an equal blend of graphics and video
2) animation is very important; kids like it
to be effective, animations must move at a medium rate of speed
3) written word labels very helpful

II. DESIGN AND APPROACH [continued]

5. Should all learners be presented with a variety of strategies or should one strategy be primary and alternative strategies be presented only to those who don't get the first way?

As much as possible, information should be matched to learning style. A truly interactive program can individualize instruction. Watson has performed 6-8 research studies on learning style. Most software fits field independent learners, ie thinkers who view things linearly; they are problem solvers who see things as the sum of their parts (convergently). Ideally, videodiscs should screen children and match information to their style of learning. The technology offers great hope to field dependent (divergent) thinkers.

6. Should there be recordkeeping system? If so, what information, other than number of attempts, should be provided?

Yes. Give individual scores for separate constructs, and automatically feed the child back to the problem area
1) Test each segment 2) Review 3) Provide overall score.

7. What should be the teacher's role?

Videodiscs can be appropriately used by child alone and by child + teacher. While children don't need the teacher, from a p.r. perspective it's a mistake to exclude teachers

8. What techniques/strategies are you familiar with that you think would enhance this effort?

1) Children learn best using the upper right quadrant of the screen. The order of preference for learning is

2	1
4	3

2) Young handicapped children can use a mouse
3) use vocabulary child can understand: big turn, little turn, big step little step — these are pre-math constructs.

III. CONTENT

1. Do you think the proposed videodisc should be used for introducing content, as a reinforcer of content already learned, or for a combination of both?

Should be a combination of both. Query kids and then branch according to their answers. Match learning styles accordingly.

2. Do you have any suggestions for integrating the videodisc into ongoing preschool programs?

What doesn't work: Schools don't have the necessary equipment. We must make the videodisc Level III.

What does work: 1) Have components of a generic video and allow children to reincorporate (ie random frames) 2) Build in generic components that are not part of the basic track such as data bases (e.g. glossary, photos). Children be taught to navigate through data bases on his/her own.

3. Do you think we can use the same concepts as foundations for both math and science, or do you feel there should be a delineation between the two?

There should be a delineation, but the same constructs can be used.

4. How many concepts is it feasible to include? Would you suggest fewer concepts in more depth or multiple concepts at an introductory level?

Do a few well. Provide children with the necessary tools.

III. CONTENT [continued]

5. Here are some topics we've been considering focusing on in the videodisc:

CLASSIFICATION	[including observing attributes, sorting, and comparing and contrasting]
SERIALIZATION	[arranging things according to properties such as height, weight, and temperature]
NUMBER	[one-to-one correspondence, counting
TIME	[units of time, sequencing of time]

How do you react to these? Do you agree with this approach, or would you go another route? What other topics would you feel it's important to include as *foundations* for math and science?

These are most appropriate. Advice: start with classification since kids have to learn this and it's easiest for teachers.

IV. ADDITIONAL THOUGHTS AND RECOMMENDATIONS

(II-1) cont: done at UNC: Four groups were examined
(1) teacher present and responding
(2) teacher present and doing spontaneous teaching
(3) teacher using text of videodisc in didactic teaching
(4) control
Both videodisc situations showed significant increases in learning, although teacher's method didn't make a difference statistically

Preschool Math & Science SBIR Telephone Interview

INTERVIEWEE Donna Wolfinger

DATE 11/16/89 PHONE NO. (205) 244-3820

AFFILIATION Assistant Professor of Math and Science Education EXPERTISE Early childhood math & science

~~ADDRESS~~ Auburn University

I. DEMOGRAPHIC BACKGROUND

1. Experience in early childhood education?	☑ YES 4 YEARS ☐ NO
2. Experience in special education?	☐ YES _____ YEARS WITH COGNITIVELY IMPAIRED PRESCHOOLERS? ☐ YES ☐ NO ☑ NO
3. Experience in math/science education?	☑ YES 10 YEARS _____ WHAT AGE GROUPS? Head Start through Grade 12 ☐ NO
4. Experience in computers/software development for young children?	☐ YES _____ YEARS ☐ AS A REVIEWER? ☐ AS A DEVELOPER? ☐ AS A TEACHER/ADMINISTRATOR? ☑ NO
5. Experience in videodisc development?	☑ YES _____ YEARS _____ WHAT AGE GROUPS? adult students WITH HANDICAPPED CHILDREN? ☐ YES ☑ NO ☐ NO

II. DESIGN AND APPROACH

1. How applicable do you think research on software for preschoolers is to the use of videodisc with 3 to 5 year olds?

Yes, it's applicable

2. How long do you think we can expect mildly cognitively impaired 3 to 5 year olds to sit at a computer using a videodisc?

N/A

2a. Would there be any appreciable difference in the time that nonhandicapped children could spend at a computer?

N/A

3. What can be done to maximize the children's interest in using the videodisc?

N/A

3a. Are you aware of any research on the use of videodisc as a motivational tool for young children?

N/A

4. What suggestions would you make in terms of graphics? For example, should there be more video and less computer graphics? What about use of animation? Does it help or is it distracting? What about use of written words as labels, etc.?

N/A

II. DESIGN AND APPROACH [continued]

5. Should all learners be presented with a variety of strategies or should one strategy be primary and alternative strategies be presented only to those who don't get the first way?

N/A

6. Should there be recordkeeping system? If so, what information, other than number of attempts, should be provided?

What errors were being made so that teacher can analyze patterns and take prescriptive action

7. What should be the teacher's role?

1) The teacher should have input into development
2) She should "diagnose" what the child is to use
3) She should select appropriate materials and see how they can be adapted and integrated
4) She should be a facilitator - diagnosing and sequencing events

8. What techniques/strategies are you familiar with that you think would enhance this effort?

Make the program interactive. The child needs to direct what's occurring.

III. CONTENT

1. Do you think the proposed videodisc should be used for introducing content, as a reinforcer of content already learned, or for a combination of both?

Prefers that videodisc be used to reinforce information learned through direct hands-on experiences in the classroom. Let the child have direct experience first, then use the videodisc to reinforce this experience.

2. Do you have any suggestions for integrating the videodisc into ongoing preschool programs?

It will depend on the structure of the program. In unstructured programs that are choice-centered, the videodisc would be another learning center option. For more structured settings, teachers will need advice on relating ~~develop~~ the videodisc to development.

3. Do you think we can use the same concepts as foundations for both math and science, or do you feel there should be a delineation between the two?

Definitely use the same concepts since at the preschool level there is so much overlap. It would be almost absurd to try to pull them apart. Children don't think in sections.

4. How many concepts is it feasible to include? Would you suggest fewer concepts in more depth or multiple concepts at an introductory level?

Fewer concepts at an indepth level.

III. CONTENT [continued]

5. Here are some topics we've been considering focusing on in the videodisc:

CLASSIFICATION	[including observing attributes, sorting, and comparing and contrasting]
SERIALIZATION	[arranging things according to properties such as height, weight, and temperature]
NUMBER	[one-to-one correspondence, counting
TIME	[units of time, sequencing of time]

How do you react to these? Do you agree with this approach, or would you go another route? What other topics would you feel it's important to include as *foundations* for math and science?

Excellent choices. Math Their Way is an excellent resource to consult. Topics to cover: classification, patterning, observation, comparing and contrasting, graphing, space relations, single measurement (using body parts instead of ~~rulers~~ rulers), immediately apparent cause and effect relationships.

IV. ADDITIONAL THOUGHTS AND RECOMMENDATIONS

Reservation: the videodisc should not take the place of toys and other manipulatives

Highlight pre-science and pre-math skills

Appendix F

Summary of Design Team Meeting

SUMMARY

DESIGN TEAM MEETING: DECEMBER 18, 1989

OSEP-Funded SBIR Feasibility Study

Investigation of Interactive Technologies

For Early Math and Science Concepts

For Preschool Children

Meeting Participants:

Louise Appell, Macro Systems
Ellen Bialo, Interactive Educational Systems Design
Laura Colker, Macro Systems
Jane Hauser, OSEP
Carolyn Harris, Macro Systems
David Hopwood, Video Software Associates
Elaine Robey, Macro Systems

Prior to the meeting, participants received copies of the literature review and proposed agenda.

Following introductory remarks by Louise Appell, Laura Colker gave an overview of the components of the document sent to design team members:

- A review of the literature
- An overview of the expert interviews, and
- The product review.

Each of these subjects was discussed in turn.

With respect to the literature review, the following comments were offered:

- Address the need for a multicultural product. The videodisc should be appropriate for children who are not white and middle class as well as children who are of this background. It was suggested that we should look at the ALERTA program out of Teachers' College as well as the *Creative Curriculum* on which Laura Colker is a contributing author.

- Consider developing a Spanish language version of the videodisc.

- In the section on computer access (pp. 1 - 4), add the need to "childproof" the computer, i.e. disable inappropriate keys.

- To the list of characteristics of appropriate software (pp. 1 - 5), add a sense of playfulness/silliness.

In general, participants felt that the literature review provided an appropriate frame of reference for development. Several participants, however, felt that the point should be underscored that research in this area is sketchy at best. The dearth of longitudinal data noted by Haugland and the descriptive nature of most research as indicated by Rettig were felt to be important cautionary advice.

In going over the results of the expert interviews with the group, it was decided to react to comments to each question as a group and thus resolve any discrepancies that had emerged. Each question was reviewed in turn. (Note: The reader is referred to Section II, pages 2 - 7, for a summary of the expert interviews by question.)

A. Design and Approach

1. *How applicable do you think research on software for preschoolers is to the use of videodisc with three to five year olds?*

   The design team agreed that research would be applicable, although the point was made that much of the research we're dealing with is subject to question and all of the research appears to be short-term in nature.

2. *How long do you think we can expect mildly cognitively impaired three to five year olds to sit at a computer using a videodisc?*

   The group agreed that 10 minutes is probably a good "ballpark" figure to work with, although it was noted that there will be variance according to the child's age, experience, and handicapping condition.

2a. *Would there be any appreciable difference in the time that nonhandicapped children could spend at a computer?*

   Here, too, the group agreed with the experts "in general" that there would be no appreciable differences. It was mentioned, though, that children who have attention deficits would be unable to sit at a computer for 10 minutes at a time.

3. *What can be done to maximize children's interest in using the videodisc?*

   The design team concurred with the suggestions offered by the experts, cautioning, though, that the use of graphics and action should be employed for a reason, not merely for its entertainment value.

3a. *Are you aware of any research on the use of videodiscs as a motivational tool for young children?*

The group felt that the first three items mentioned by the experts were extremely important, i.e.

- Don't make children wait
- Never let a screen fade out completely, and
- Use smooth transitions.

4. *What suggestions would you make in terms of graphics? For example, should there be more video and less computer graphics? What about the use of animation? Does it help or is it distracting? What about the use of written labels?*

In discussing the relationship between the proportion of video to computer graphics, one member of the design team took exception to the statement that video segments were not by nature interactive. The design team as a group felt that the appropriateness of the content to either video or computer graphics should be the driving force behind the decision. The point was raised, however, that even though video can be on the screen at points of interaction, it may at times be more costly to use still video images than graphics. A further caution raised during this discussion was that graphics and video should not necessarily be thought of in separate terms. Animation was likewise presented as an option which, because of the high costs involved, is not always the most cost-effective choice. However, the design team concurred with the experts that animation is important to include when it is appropriate to do so for educational reasons. The design team unilaterally felt that written labels should be used. The comment was made, however, that the ability to read these labels should not be a prerequisite for using the program.

5. *Should all learners be presented with a variety of strategies or should one strategy be primary and alternative strategies be presented only to those who don't get the first way?*

In discussing this question it became clear that the intent of this question had been to explore representations of teaching a concept -- not strategies. Given this, the group felt that we would want to provide all children with lots of representations of the same concept in order to facilitate learning.

6. *Should there be recordkeeping system? If so, what information other than number of attempts should be provided?*

The group initially sided with the two individuals who felt that a recordkeeping system should be dropped. Upon further discussion and an examination of whether the High/Scope rating system downgrades software programs for not including a recordkeeping system (Answer: It doesn't, although it does note whether or not this feature is present), it was decided that we ought to contact gatekeepers to see if there would be a negative reaction to not including a recordkeeping system with the videodisc. The general consensus of the group was that the costs of developing a recordkeeping system would not be an appropriate trade-off if content were to suffer.

7. *What should be the teacher's role?*

Here the group concurred with the experts that the teacher should serve as a facilitator and a diagnostician.

8. *What techniques or strategies are you familiar with that you think would enhance this effort?*

In addition to the ten suggestions noted, it was suggested that "consistent screen design" be added to the list.

B. Content

1. *Do you think the proposed videodisc should be used for introducing content as a reinforcer of content already learned , or for a combination of both?*

   The design team strongly felt that the videodisc could and should serve either function.

2. *Do you have any suggestions for integrating the videodisc into ongoing preschool programs?*

   The group agreed with the suggestions offered by the experts, in particular the need to integrate the videodisc into ongoing classroom activities.

3. *Do you think we can use the same concepts as foundations for both math and science, or do you think there should be a delineation between the two?*

   There was group consensus that math and science concepts be combined. One participant like the comment cited from the interviews that "It would be almost absurd to pull them apart. Children don't think in sections."

4. *How many concepts is it feasible to include? Would you suggest fewer concepts in more depth or multiple concepts at an introductory level?*

   The guidance provided by the design team was, "Do as many as you can do well."

5. *Here are some topics we've been considering focusing on in the videodisc*

(classification, seriation, number, time). How do you react to these? Do you agree with this approach or would you go another route? What other topics would you feel it's important to include as foundations for math and science?

There was general support for both this approach and topics. Classification was felt to be the most important topic, followed by seriation. Because number is covered by so many software programs, it was though to be less useful. Time was felt to be a difficult concept to teach pre-operational children.

No other additional comments were made by the group to supplement those provided by the experts.

The product review was noted to be complete with no other discussion offered.

The second half of the design team meeting was devoted to exploring scenarios and brainstorming ideas for possible inclusion in the videodisc. There was general agreement among the members of the design team that the videodisc be perceived as an umbrella for helping students employ the scientific method to acquire math and science concepts. By observing and exploring data, children would learn to classify data, order it, and display information in simple graphs. Some possible visualizations provided by the design team for helping children learn these concepts include the following:

- Furniture in rooms
- Clothes
- A garden
- The ocean
- Toys
- Holidays
- Weather
- Buildings
- Transportation

- Occupations
- A grocery store
- Animals
- Parts of the body (including disabled people's bodies)
- Bugs
- Plants
- A hardware store
- The zoo
- A nature walk
- An aquarium
- The fire station
- A pet store
- A florist shop or nursery

It was felt that those topics that lent themselves to teaching math through science (e.g. a garden, the ocean, weather, bugs, a nature walk, the zoo, a florist or a pet store) would be preferable for our purposes.

Attention was next focused on what the structure of the videodisc should look like. Overall two major decisions were reached:

- A mouse would be the best interface for this age group based on the literature, and
- Children should be provided with three to four different environments from which they could choose. For example, children would be asked whether they wanted to explore a garden, the ocean, a grocery store, or a zoo. Using a mouse, they would then point to the video representing these topics. Graphically, the suggestion was made that these different environments could be depicted as panes in a four pane window, each pane allowing the child to see into a particular environment:

Other suggestions made by the design team regarding the structure of the videodisc included:

- Progress should be inherent in the program, but not visibly tracked.
- The program need not be structured by a story line.
- Stop and Help should always be present.
- Prompting can be accomplished by voice; timing mechanisms should be avoided.

- Icons should be developed to represent Explore, Classify, and Seriate.
- A teacher's guide should accompany the videodisc, with examples of how to work with the system.

The meeting was adjourned with requests for this report so that participants might further reflect on decisions made at this meeting.

END

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Date Filmed

March 29, 1991